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AN IRRIGATION CONGRESS will be held at Salt Lake City, Utah, Sept. 15, 16 and 17, with the object of discussing means to induce the national and state governments to enact laws for the irrigation and improvement of arid lands so that these lands may be settled and developed. Numerous delegates have been invited to attend, and a large meeting is expected. Mr. F. K. GILLESPIE is the Secretary of the Committee of Arrangements.

THE ASSESSED VALUATION OF REAL AND PERSONAL property in the United States, says Census Bulletin 104, has doubled in 30 years, or increased in the following ratio:

Years.	Assessed value.	Estimated true value.
1860.....	$12,084,560,005	$16,159,616,068
1870.....	14,178,986,732	30,068 518 507
1880.....	16,902,903,543	43,642,000,000
1890.....	24,249,589,804	.....

The estimate of true value is more or less incomplete and imperfect, and prior to 1880 no attempt was made to go inside of the assessors' returns. But supposing that the same ratio holds good, as in 1840, the true absolute wealth of the United States is about $62,610,000,000. This is nearly $1,000 per capita, as compared with $514 in 1860, $780 in 1870 and $870 per capita in 1880. The richest States in 1890 were: New York, Pennsylvania, Massachusetts, Ohio and California, as given. The assessed valuations in these States ran from over 3,775 millions to 1,071 millions. The richest State per capita is Massachusetts, with $902.12 of assessed values; Rhode Island comes next with $931.28; California with $886.58; then Montana, $805.04; New Hampshire, $671.19, and New York with $629.45. South Carolina has but $114.83 per head; Mississippi, $122.15, and Alabama, $130.26.

SOME LARGE LOCOMOTIVES FOR SUBURBAN TRAFFIC have recently been built for the New York Central & Hudson River R. R. by the Schenectady Locomotive Works, of Schenectady, N. Y. They have 6 driving wheels, a leading Bissell or pony truck and a six wheel truck under the rear tank and bunker, which are carried upon the extension of the main frame. Cylinders, 18 × 22 ins. Driving wheels, 64 ins. diameter; truck wheels, 30 ins. The boiler is of the wagon top style, with barrel 56 ins. diameter, and of steel ¼-in. thick. The firebox is 108⅞ ins. long, 42⅛ ins. wide, and 64¾ and 54¾ ins. deep at front and back. There are 254 iron tubes, 2 ins. diameter and 11 ft. long. Heating surface: tubes, 1,451.8 sq. ft.; firebox, 144.9 sq. ft.; total, 1,596.7 sq. ft. Grate area, 31.9 sq. feet. Boiler pressure, 180 lbs. Height from rail to top of smokestack, 14 ft. 6 ins. Driving and rigid wheel base, 12 ft. 9 ins.; wheel base of driving wheels and leading truck, 20 ft. 4 ins.; total wheel base, 35 ft. 7 ins. Weight on driving wheels, 95,000 lbs.; on leading truck, 16,000 lbs.; on trailing truck, 52,500 lbs.; total weight, 163,500 lbs. The tank and bunker have capacities of 2,300 galls. of water and 2¾ tons of anthracite coal respectively.

SALTON LAKE, in Southern California, is still rising, say California dispatches, and it now covers about 288,000 acres, or 35 miles long and 12 to 15 miles wide. One of the two streams entering the lake from the Colorado river is 500 ft. wide, 2 to 3 ft. deep, and has a velocity of 5 miles per hour.

THE BUFFALO, N. Y., BREAKWATER, now being built by the government, under Major AMOS STICKNEY, U. S. Engineers, will cost about $200,000. The work consists of replacing about 2,000 ft. of the old wooden breakwater with concrete masonry, and building a timber extension 450 ft. long at the south end. When finished this fall the entire breakwater will be 6,805 ft. long. Two sections of concrete masonry were built by Capt. MAHAN in 1887-89, and form the first section. Then come 1,458 ft. of old wooden structure and the 2,000 ft. of concrete work now building, and finally the 450 ft. of timber. The concrete wall is founded on cribs filled with stone in water 38 ft. deep at places. This concrete wall is 38 ft. wide at the water level, and is built of concrete blocks 6 ft. long, 4 ft. high and 4 ft. 2 ins. wide, on the outside filled in between with concrete.

WORK ON THE LEAGUE ISLAND NAVY YARD, at Philadelphia, is progressing, though slowly. About 100 are at work on the sea and retaining walls under Mr. C. C. WALCOTT, Civil Engineer, U. S. N., and James A. Mundy & Co. are the contractors. A pier 393 ft. long and 100 ft. wide is being also built, resting on piles and faced by a heavy wall of concrete to retain the earth filling. A sea wall of concrete on piles and a platform will be 500 ft. long; and of this 300 ft. is finished and work is in progress on the remainder. Another sea wall is to extend 5,000 ft. to the eastern extremity of the island, and of this 2,500 ft. is now nearly finished, and the remainder will be commenced this fall. The marshy ground back of this wall is to be filled with the material dredged up in removing Smith's and Windmill Islands, in the Delaware Harbor. This filling is now in progress. The dredged material is dumped in the river in front of the wall and then picked up by a powerful steam ejector, or vacuum pump, with a 26-in. pipe, stationed on a flatboat placed over the mud. It is thus lifted over the sea wall and on to the land.

THE NEW ORLEANS LEVEE BOARD has condemned about $250,000 worth of real estate for the purpose of rebuilding, on a new site, the Carrolton levee. The new levee, planned by City Surveyor HARROD will cost about $500,000 and will necessitate the abandonment of a strip of land 3,750 ft. long by 350 ft. wide in a business part of Carrolton. As the State law makes no provision for paying for land expropriated for levee purposes this property will be a total loss to its present owners. But they propose to fight for it and a committee has been appointed to enjoin the Levee Board from carrying out its plans.

A WORLD'S FAIR TOWER 1,150 ft. high has been designed by Mr. GEORGE S. MORISON, the well known civil engineer and bridge builder. From the few notes accessible this tower would have a base of 440 ft. square, with two landings of 250 and 150 ft. in diameter respectively and the lantern at the top 60 ft. in diameter. There would be eight elevators of a capacity of 50 people each; two running to the top without a stop. The combined carrying capacity would be 7,500 per hour. The estimated cost of the tower, ready for steam connection, is $1,900,000; but the estimated net revenue is figured at $4,000,000.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a crossing collision on the Baltimore & Ohio R. R., at Lodi, O. An excursion train was standing on the track, with the rear sleeping car on the crossing of the New York, Lake Erie & Western R. R. A coal train on the latter road ran into the sleeping car, overturning it and throwing it into the ditch. None of the 28 passengers were seriously hurt. A collision on the New York & Greenwood Lake line of the New York, Lake Erie & Western R. R. occurred at Montclair, N. J., Sept. 3. The engine driver of a freight train failed to get his train on to a sidetrack in time and collided with a passenger train.

A SERIOUS COLLISION ON THE BROOKLYN BRIDGE cable railway occurred Sept. 4. A four-car train arrived at the Brooklyn station on time, at 9:15 P. M., and while the passengers were leaving it an engine backed down to draw it away from the platform. The automatic coupling failed to work, and the engine, after drawing ahead a few feet, was again backed down. Again the coupling did not work, and then the fireman stepped down between the engine and the front car of the train and fastened the coupling chains. All this required time, however, and as the trains were being run on 3 mins. headway, another train was bearing down on the rear of the stationary one. Just ahead of the latter was a green light about 500 ft. from the station. Further on there was another green light and still further a red one. These are cautionary signals and are exposed whenever a train occupies the track at the platform, and it is a rule that no train must pass the red light, which is at the end of the platform. A separate signal is placed at the end of the bridge structure itself; and when at the danger position a train must stop and not run on to the approach. The head brakeman, however, disregarded the signals, and when the train dispatcher and the brakeman of the standing train waved their red lamps across the track there was not time to stop. The firemen was crushed between the engine and the standing train, while two persons on the front platform of the second train were thrown down and injured. The blame is placed upon the head brakeman of the second train. There is continual danger of such accidents during the busy hours of the day, when crowded trains of 4 cars are run on 90 seconds headway.

A LOCOMOTIVE BOILER EXPLOSION occurred at Oyster Bay station on the Long Island R. R. Sept. 9. The engine had just been run out of the roundhouse and attached to a train, and was waiting for the signal to start, when the boiler exploded, tipping the engine up on end, with the smokestack on the ground. The engine-driver, fireman and a brakeman were killed, and the conductor, who was standing beside the engine, badly scalded. The boiler had been recently examined and washed out. It is said to have been blowing-off at the time.

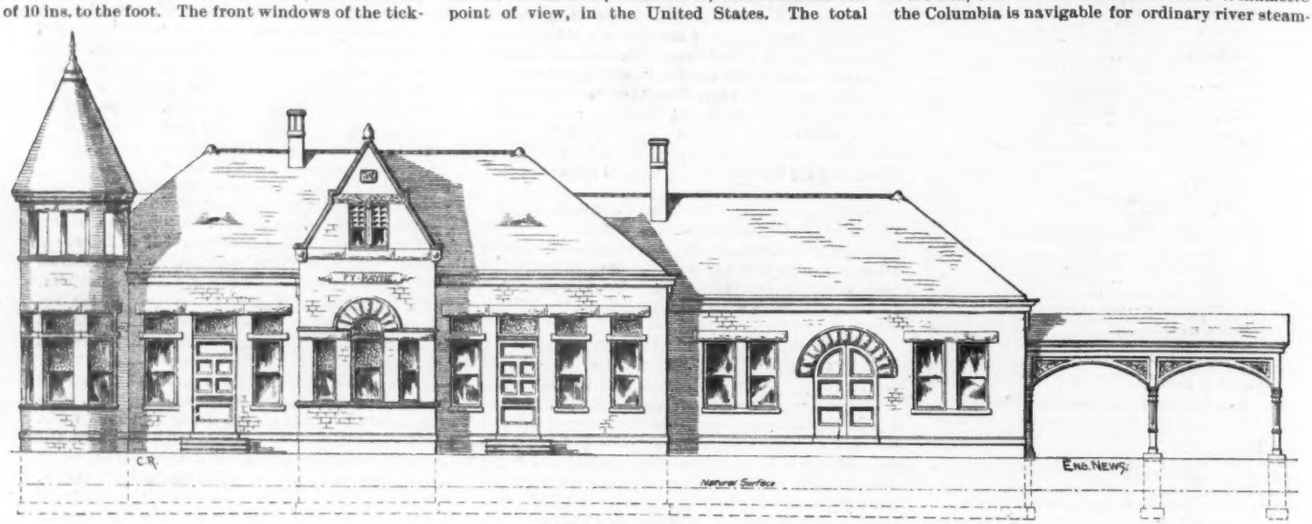
A TRESTLE at Clay City, Ky., on the Kentucky Union R. R. gave way under a freight train Sept. 7. One man was killed and another injured. A trestle at Aberdeen, Miss., on the Raleigh & Augusta road, has been washed out. A trestle at Dorcheat, Miss., on the Vicksburg, Shreveport & Pacific R. R., was burned Aug. 31.

TERRORITE is a new nitro-glycerine compound invented by Prof. MINDELEFF, of San Francisco, and tested at Fort Hamilton this week by Cols. H. L. ABBOTT and ALFRED MORDECAI, U. S. A. It is claimed by the inventor to be six to eight times stronger than commercial dynamite, and to be unaffected by jarring or an ordinary degree of heat. While the result of the official test has not yet been made public, Col. ABBOTT said it was no more powerful than other explosives known. Future tests will decide whether it can be fired from cannon with powder, as claimed.

Passenger Station at Fort Payne, Ala.; Alabama Great Southern R. R.

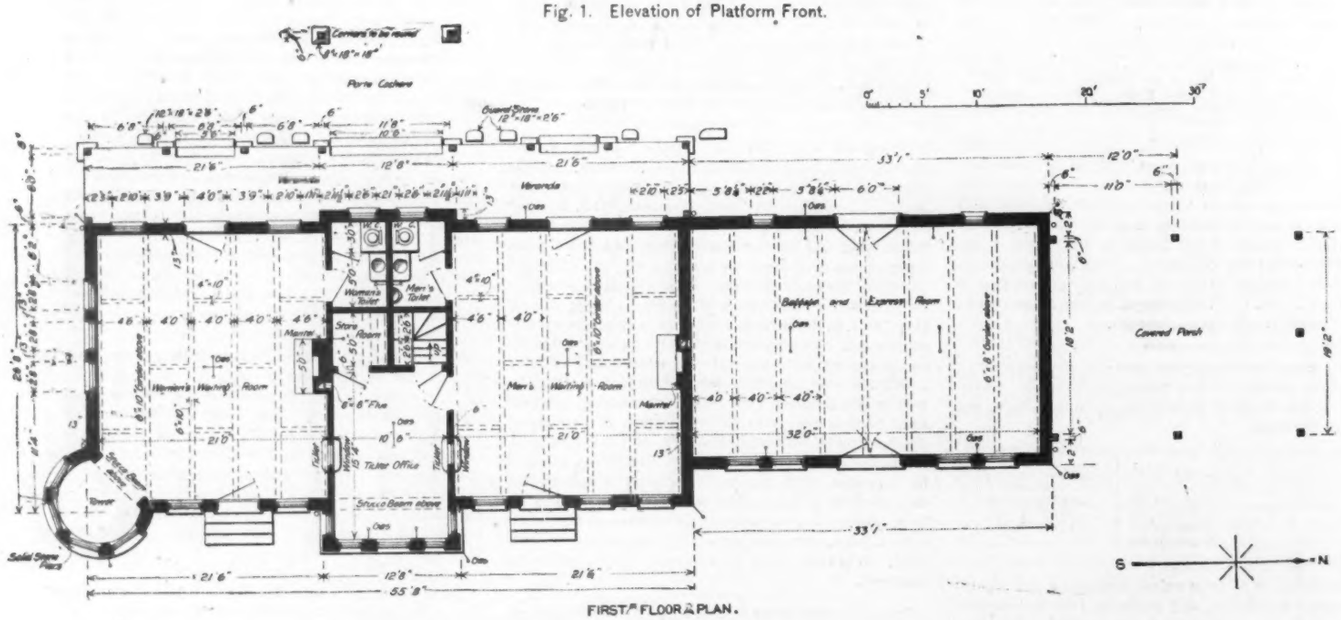
We present in this issue elevations and a general plan of the new station at Fort Payne, Ala., on the Alabama Great Southern R. R., which forms a part of the Cincinnati, New Orleans & Texas Pacific Ry. system. Mr. GEO. B. NICHOLSON, M. Am. Soc. C. E., is the Chief Engineer.

The building is of brick, with stone trimmings, the exterior walls being 13 ins. thick. The foundation walls and the upper part of the tower are of stone. The roof is covered with slate, and has a rise of 10 ins. to the foot. The front windows of the ticket office have the lower part of sand-blast glass, and the upper part of stained glass. The transom lights of the waiting room windows are also of stained glass. On the street side of the building is a piazza in front of the waiting-rooms, with a porte-cochère under which can carriages take up and set down passengers. At the north end of the building is a covered porch, about 24 ft. × 19 ft. Here are separate waiting rooms, each 21 ft. × 24 ft. 6 ins., for men and women, but it will be noticed by the plan that there is no direct communication between them. This appears to be a rather inconvenient feature in the arrangement, and a connecting passageway might easily have been provided. The ticket office is 15 ft. 4 ins. × 10 ft. 6 ins., and projects beyond the line of the building. The baggage and express room is 32 ft. × 21 ft. The rooms are heated and are lighted by gas. Gas lamps are also fitted on brackets on the outside, as shown.



FRONT ELEVATION.

Fig. 1. Elevation of Platform Front.



FIRST FLOOR PLAN.

Fig. 2. Plan.

PASSENGER STATION AT FORT PAYNE, ALA.; ALABAMA GREAT SOUTHERN R. R.

The Proposed Boat Railway Around The Dalles Rapids of the Columbia River.

(WITH INSET.)

The Columbia River is, after the Mississippi and its tributaries, and the rivers connecting the Great Lakes, the most important river, from a commercial point of view, in the United States. The total territory embraced in its watershed is over 245,000 sq. miles in extent, or larger than New England and all the Middle States, with Ohio and West Virginia. Included within this territory in the States of Washington and Oregon are great areas of productive farming land, a large part of which has recently been brought under cultivation, and now supplies a large surplus of wheat and grain for export. The value of the breadstuffs exported from custom districts on the Pacific Coast amounted to $35,289,000 in the year ending June 30, 1891, an increase of about $5,000,000 over the exports of the preceding year.

Cheap water carriage for the part of this great grain crop grown on the plains bordering on the Upper Columbia is likely to be urgently demanded of the general government. Up to this time the principal work done by the government for the improvement of navigation on the Columbia is the building of jetties at its mouth to secure a depth of 30 ft. of water across the bar at mean low tide. This work, described in our issue of April 18, has been so far completed that a depth of 26 ft. of water has been secured. Ocean steamers can now ascend the Columbia 104 miles to the mouth of the Willamette, and then go up that stream 16 miles to the city of Portland, Ore. From the mouth of the Willamette the Columbia is navigable for ordinary river steamers to the Cascade rapids, a distance of 51 miles. At this point the river breaks through the Cascade range, and is compressed in a narrow, rock-bound gorge, 400 ft. wide at the narrowest point. The total fall of the river in a distance of about five miles is 45 ft. The variation between high and low water mark at the most contracted point is 87 ft.

In 1876 the first appropriation was made by Congress for the construction of a canal around the Cascade rapids. The total estimated cost of the work is about $2,700,000, of which a little more than half has been spent. The work has been prosecuted very slowly and in the usual expensive manner of river and harbor work, the appropriations being al-

ways insufficient to carry on the work in a rapid and economical manner. At present, however, the work is in such condition that with available appropriations it would probably require only about two years to make the canal ready for boats.

Above the Cascade rapids the Columbia is a broad, gently flowing stream over half a mile wide; and there are no obstructions to navigation until The Dalles is reached, 54 miles above the Cascade rapids. From The Dalles to Celilo, a distance of 12 miles by the river, there is a total fall of 81.4 ft. at mean low water and 62.5 ft. at mean high water. At Celilo there is a fall of 47 ft. At Ten-mile rapids and at The Dalles rapids the river is contracted in a narrow flume, with vertical basalt walls, leaving a channel only 125 to 350 ft. in width. The fall is from 7¼ ft. to 11 ft. per mile. The fall in the Three-mile Rapids at low water is more moderate, the total fall from Big Eddy to Dalles City being only ¼ ft.

SOUTH SIDE ELEVATION.

Fig. 3. End Elevation, Passenger Station, Fort Payne, Ala.

These obstructions at present constitute, of course, an impassable barrier to navigation; but for a dozen years the possible methods of overcoming them have been under investigation by the government engineers. We have already explained that with the completion of the canal at Cascade rapids, on which nearly a million and a half has been spent, navigation will be unimpeded from the mouth of the Columbia to The Dalles, a distance of 210 miles. Above Celilo navigation is good at all stages of the water to Priest Rapids, a distance of 189 miles, or about 400 miles from the mouth of the river. Boats can also ascend the Snake River at all stages as far as Lewiston, 108 miles from its junction with the Columbia. The obstructions to navigation at Priest Rapids were surveyed in 1888, and it was estimated that they could be made passable for boats at an expenditure of about $150,000. Above Priest Rapids there are long stretches of navigable water, with some obstructions in the way of rapids which could be made passiable at small cost. Steamers are now running on the upper Columbia from the British border through the northern part of Washington, a distance of over 1,000 miles from the river's mouth. The valley of the upper Columbia has had a very rapid growth during the past five years, and water transportation for its grain product would do much to further this development. It is quite probable, therefore, that works of some sort for overcoming the obstructions to navigation at The Dalles rapids will be carried out within a few years.

In the River and Harbor act of 1888 the Secretary of War was directed to appoint a board of three engineers to investigate the obstructions to navigation at this point, and report what in their judgment was the best means for overcoming them. The Board appointed consisted of Col. G. H. MENDELL, Col. WM. P. CRAIGHILL, and Maj. JAS. C. POST.

Various plans were presented for the Board's consideration. Major THOS. H. HANDBURY, Engineer in Charge of the Cascade canal work, submitted plans for a system of locks and canals, at an estimated cost of $3,754,355. The Board criticised this project on account of its cost, which they believed would be largely exceeded, and on account of the time necessary to carry it out. The Board favored the use of hydraulic lifts rather than locks at the ends of the canal; but even with this modification it did not consider the canal scheme the best solution of the problem.

Major W. A. JONES proposed two incline boat railways with a maximum grade of 10%, to be operated with a car of special construction intended to carry the boat dry in a horizontal position during transit. He proposed to return the boat to the river to make the passage from the head of The Dalles rapids to a point below Celilo Falls. At the request of the board he modified this plan, substituting a continuous boat railway from Big Eddy to a point on the river above Celilo, a distance of 45,100 ft. The track was to be of 6 double lines of rails, supplemented by 6 additional rails on the curves. The maximum grade proposed was 1% and the maximum curve 2°. The car was a platform 165 ft. long and 39 ft. wide, resting upon 120 cast iron wheels having broad chilled treads without flanges. The car was to be kept on the track by two sets of guide wheels so placed that the bearing wheels would rest in every position of the car on at least two rails.

The Board, however, rejected both the track and the car designed by Major JONES, substituting for the former two parallel tracks laid with 90-lb. rails, and for the latter a car designed by Lieut. EDWARD BURR, to whom was intrusted the work of formulating the scheme.

Upon our inset sheet we have illustrated this proposed car with the hydraulic lifting dock which the Board substituted in place of the incline terminals. This substitution was made as the result of a careful investigation, during which the board visited the hydraulic lifts at Anderton, England; Fontinettes, France; La Louviere, Belgium; Victoria lifting docks at London, and the inclined planes at Meaux, France, and on the Monkton canal near Glasgow, Scotland.

As a result of its investigations, the board recommended, first, the construction of an ordinary railway for the transhipment of passengers and freight around these obstructions. The estimated cost of construction was $431,500, and it could be built in one year. Second, as this railway, while ample for the traffic then existing, might not answer future requirements, and necessitated a large expense for the transhipment of freight, the board caused to be prepared detailed plans for the construction of a boat railway from Big Eddy to a point above Celilo Falls, designed to carry vessels weighing, loaded, 600 tons, and 165 ft. in length, 38 ft. beam and 5 ft. draft. The estimated cost of this work was $2,800,356. The report of the board favoring the construction of a boat railway was approved by GEN. THOS. L. CASEY, Chief of Engineers, who recommended it as a feasible scheme and the best solution of the problem. It was also approved by Secretary PROCTOR. A bill appropriating the estimated cost of the improvement was passed by the Senate at the last session of Congress; but when considered in committee by the House of Representatives, opposition was developed and no vote was taken upon it.

There is much reason to believe, however, that the project will yet be taken up and carried to completion. With the Cascades Canal open, the obstructions which this boat railway proposes to overcome will be the only obstacle to the passage of grain-laden boats from the Upper Columbia and Snake rivers to a market at Portland, where their cargo can be transferred to ocean vessels for export. Careful expert investigation has shown the boat railway to be much superior to a canal for overcoming the obstacles, and that it can be built within a reasonable time at a moderate cost. Should the Chignecto enterprise fail of completion for some years (which we trust may not be the case) it may yet happen that the first ship railway in the world will be built and operated by the United States Government.

On our inset sheet will be found a map and profile of the proposed railway, and illustrations of the car and hydraulic lifts. From the report of Lieut. EDWARD BURR, who at the request of the board elaborated the project in sufficient detail to form a basis for estimating the cost, we extract the following description of the enterprise. In justice to Lieut. BURR, it should be said that the time allowed for the preparation of all the details included in the report was limited to less than three months, which was quite insufficient for the proper consideration of the original portions of the scheme, and advisable changes in some matters of detail were evident before the completion of the report, though the time did not permit their being made.

THE ROAD-BED.

The location of the proposed railway is shown by a map. The project includes the removal of obstructions to navigation in the Three Mile rapids below Big Eddy at an estimated cost of $170,000. At the termini of the railway will be hydraulic lifts for taking a boat from the river and returning it thereto. The railway is located on the north banks of the river. The ground is so rugged that a rectilinear alinement or an alinement composed of tangents connected by turn-tables was out of the question. Maximum curves of 2° are used, with no elevation of the outer rail. At the middle of the line a turnout with 2 curves about 1,700 ft. in length (not shown on the map) is provided to permit cars going in opposite directions to pass each other. The total length of the line between the faces of the lift is 8½ miles.

As seen by the profile of the line, the total rise between termini is 52 ft. At the termini the road is level and the maximum grade used is 0.6% (= 31.68 ft. per mile). Different gradients are connected by vertical curves of 80,000 ft. radius. The cars and boats are sufficiently flexible to accommodate themselves to this deflection.

One feature which makes the work especially difficult is the variation between high and low water, which is 66.6 ft. at the foot of The Dalles Rapids and 28.29 at the head of Celilo Falls. The lower 12,000 ft. of the line will be submerged at extreme high water from 0 to 10 ft. But as all the excavation on the whole line is in basaltic rock, all fills will be made of rock with the slopes laid by hand. Where track is likely to be subjected to a current, masonry protecting walls will be built; and the ties along the section liable to submergence may be weighted.

The width of the top of the roadway on embankments will be 38 ft., with side slope of 1 to 1. The cuttings will have a bottom width of 45 ft. and side slopes of 4 on 1.

There will be two tracks of standard gage, spaced 20 ft. apart on centres. Fir ties 8 ins. × 10 ins. × 10 ft., spaced 22 ins. on centers will be used, with every fifth tie 30 ft. long, extending across both tracks. Rails will weigh 90 lbs. per yd., and ballast will be of broken stone.

THE CAR.

We quote from the report as follows:

The boats are of the usual stern wheel river type with flat-bottomed hulls, molded toward the bow and stern and rounded at the lower corners of the midship section. Practically, strongly built boxes of small height compared with their length and considerable longitudinal flexibility, notwithstanding a trussing of "hog frames." The dimensions were given above.

It is required of the car that it shall transport with safety the loaded boat or barge and have sufficient flexibility to pass over the horizontal and vertical curves of the above line. The maximum load to be carried is estimated at 600 tons.

The proposed car is composed of a platform of plate girders and a system of four-wheeled trucks to carry it. The platform is 168 ft. long by 38 ft. wide. It is braced for lateral stiffness and its comparatively small depth gives it a small amount of vertical flexibility. The lateral flexibility to enable the car to pass around curves is obtained by the arrangement of the trucks. There are 34 trucks, placed in two lines of 17 each. The two lines are 20 ft. apart between centers, the trucks of each line are 10 ft. between centers, and the wheels of each truck 5ft. between centers, giving a regular spacing on the rails of 5

ft. intervals. In each line the fourth truck from each end is pivoted in the usual manner, giving two pairs of trucks 100 ft. apart, which serve to guide the car on the rails. The remaining trucks have a freedom of motion laterally of sufficient amount to permit them to accommodate themselves to the alinement of the track. This freedom is obtained by pivoting the trucks about a point 8½ ft. from their centers by means of radius bars, which also serve to hold the trucks to their places longitudinally. The motion takes place upon sets of rollers interposed between the platform and the trucks. For a chord of 100 ft. the middle ordinate for a 2° curve is 5.23 ins. and this is the maximum deflection for the center trucks. For the other trucks it is less.

The details of construction are as follows:

The car has a length over draw-bars of 169 ft., an extreme width of 38 ft., and a height, unloaded, of 5.1 ft. above the rails. The platform is composed of two main longitudinal trusses 20 ft. between the centers, and connected at intervals of 10 ft. by transverse trusses. The connecting points are immediately above the trucks. The transverse trusses are extended 9 ft. outside of the main trusses as cantilevers, and the outer ends of the latter are connected by a channel-bar running the full length of the platform. The centers of the transverse trusses are connected by a third longitudinal truss, and six longitudinal beams of timber assist in supporting the hull of the boat and transferring its weight to the transverse trusses.

The trucks may be of any design of sufficient strength. In the drawings is shown a truck of the iron frame, locomotive type. The wheels should be of cast steel or wrought iron. The axles have 6-in. outside bearings, the greater spread of the bearings more nearly equalizing the load per wheel when the car is on a curve. Roller-bearings are shown, as they are better suited where frequent immersion in water is required, and they are reported to have given good results in railroad service. If, on fuller investigation, this proves not to be the case, a journal and box of the usual character, but of special design for retaining the oil should be substituted. The springs are of the leaf pattern of the usual form, and extra heavy. They should yield sufficiently under the empty car to prevent the bearing being taken off the roller when any truck passes a slight inequality in the road-bed, and still not have an excessive deflection under the full load. The rollers are of steel, between steel plates, which are attached, one to the truck bolster and the other to the under side of the platform.

The weight of the car is 300 tons, of which the trucks weigh 181 tons and the platform 119 tons. The maximum weight to be carried is 600 tons, and the total weight of the loaded car is 900 tons. The average load per truck is 27.6 tons, and per wheel is 6.9 tons. But the weight of the boat is greater for the midship portion, and the platform has not depth enough to uniformly distribute it. An assumption was therefore made upon the distribution of the boat's weight, and that it is carried locally, with resulting loads of 30.3 tons per truck and 7.6 tons per wheel, both of which are within practical limits. Provision is also made in case of the failure of one truck for carrying the load to the two adjoining trucks, with resulting emergency loads of 42 8 tons per truck, and 10.7 tons per wheel. But these loads will probably not be attained, since the platform has sufficient rigidity to transfer a portion of the load beyond the two adjoining trucks.

The material of all rolled sections is presumed to be mild steel. The maximum strain for the greatest loading is restricted to 10,000 lbs. for the platform and to smaller limits for the truck.

Two 50-ton locomotives, one on each track, will handle the load of 900 tons with ease on the grades of the line at the desired speed. Automatic air brakes should be provided to assist in controlling the car and for emergencies.

THE LIFTS.

A lift is required at each end of the roadway, with a capacity to raise a live load of 900 tons. With a draft of boat of 5 ft. and a height of car of 5.1 ft., the height to be lifted at extreme low water is 40.15 ft. at the Celilo lift, and 68.2 ft. at the Big Eddy lift. Vertical hydraulic lifts are proposed, and the hydraulic ship lift now in successful operation in the shipyard of the Union Iron Works in San Francisco has been used as a model, such modifications being made as were called for by the differences in locality, load and height of lift, or as were suggested by the operation of that lift. Mr. G. W. DICKIE was the designer and constructor of the lift.

The drawings are for the lower or Big Eddy lift. The upper lift will be similar in all respects, with such a shortening in the lengths of the rams, chains and other vertical members as may be necessary to adapt it to the smaller height to be lifted.

The proposed lift consists of a platform or cradle supported by chains for the heads of a series of hydraulic rams placed in two rows, one on either side. The chains are so arranged over sheaves as to give the cradle a speed and movement four times that of the rams. A device for regulating the admission of the water to each press so controls the movement of the rams as to maintain them at a uniform speed and the cradle in a horizontal position notwithstanding any differences in the loads on the several rams. The presses and rams are inclosed in a riveted framework, which serves to steady the presses, to guide the rams and the cradle while in motion, to carry the regulating mechanism, and to support the cradle at the level of the track.

In the Union Iron Works ship lift the cradle is suspended from each ram by eight steel wire cables, and the stroke of the rams is multiplied by two. But in the shops of the company is a single cylinder hydraulic overhead crane, with a lifting capacity of 50 tons, the stroke of the ram being multiplied by four. A similar construction should therefore be practicable for a load per ram of one-half more. The details of the proposed lift are as follows:

There are 16 rams, with a full stroke of 17 ft. 3 in. They are placed in two rows, 45 ft. 11 in. between centers of rams with the rams in each row 22 ft. 6 in. between centers. Each press cylinder is 19 ft. 7 in. long, 31.5 in. interior diameter, with a 5-in. thickness of metal, and is cast in one piece weighing 19 tons. Each rests upon a base casting weighing 13.1 tons, which also carries two of the chain sheaves and supports the vertical posts of the framework. To the top of the cylinder is bolted by external flanges a guide cylinder 3 ft. 3 in. long, which is also braced to the vertical posts of the framework and to the face of the rock cut.

Each ram is 30 in. exterior diameter with a 2.5 in. thickness of metal, and is cast in one piece weighing 8.3 tons. On the upper end is bolted a top casting supporting a shaft which carries at each end two chain sheaves and a crosshead, the latter working in vertical slides bolted to the framework. The rams and the cylinders are calculated for a working pressure of 1,000 lbs. per sq. yd., and should be tested to 2,000 lbs. per sq. yd. before erection.

The average weight suspended from each ram is 67.7 tons. This weight is carried by two 2¼-in. chains, each of which should be of 100 tons proof. The fixed ends of the chains are attached to the guide cylinder casting and the running ends to the side trusses of the cradle, three sheaves being interposed on each chain to give the desired multiplication.

The cradle is composed of two side trusses 170 ft. long and 40 ft. between centers. They support the ends of the transverse trusses. The latter are 11 ft. 3 in. between centers, are symmetrically placed with respect to the rams and support 4 stringers, one under each rail.

The framework is composed of vertical posts connected at their centers and upper ends by horizontal struts, the whole braced longitudinally by diagonal tie rods, and laterally by inclined struts anchored to the rock in place.

The platform is supported as follows: On each side of every ram a 12-in. rolled I-beam is placed horizontally at the necessary height. The inner end is supported by the vertical posts just mentioned. The outer end is anchored to the rock in place when the latter is high enough, otherwise it is supported by the inclined lateral struts and anchored to the rock by vertical rods. This I-beam supports a second moveable I-beam, or chock, the outer end of which clamps over the lower beam for holding down. The entire system of chocks is operated together. Each chock is connected with the centre arm of a double bell crank. Each of the other arms of the crank is attached to one of the two rods which extend the full length of the lift. Each rod is operated by a small hydraulic ram, by means of which the line of chocks can be either moved into place or withdrawn.

The load will not be uniformly distributed to all the rams of the lift, and the ram with the smallest load would, unless controlled, rise faster or descend slower than any other. To cause all the rams, independent of their respective loads, to move at the same speed, and thus maintain the cradle horizontal and free from undue strain, is the object of the regulating mechanism.

Mr. DICKIE designed for application to the Union Iron Works ship lift a device that has given satisfaction. The principle of it is adopted for The Dalles lifts, with such modifications in details as suggested by experience. The arrangement of the device is shown on the drawings, and is as follows:

On each side of the lift a horizontal shaft is placed in bearings on the upper horizontal strut of the frame work. The shafts extend the length of the lift, are geared to the same engine-shaft, and at each ram by a worm-gearing to a vertical shaft. The latter has a bearing at its lower end on the guide cylinder, and at its upper end on the valve-box casting. The bearings and gearings permit of a small vertical motion to the shaft. It is screw threaded for a length somewhat greater than the stroke of the ram, and has upon it a nut or sleeve that is carried by the top casting of the ram. The sleeve is made in two parts, drawn together by bolts to take up any lost motion on the screw thread. The upper end of the vertical shaft is attached to one end of a lever, which is attached at the other end to the valve stem. The valve is of the ordinary slide pattern, with two ports, the upper in connection with the return or exhaust-pipe, and the lower with the interior of the press. The interior of the valve box is in connection with the supply-pipe.

Power is furnished by a pair of direct-acting steam pumping engines of about 500 total HP.

With 80 lbs. average steam pressure, and 30 revolutions per minute, the pumps will furnish 700 galls. per minute under a pressure of 1,000 lbs. per sq. in.

Supply pipes deliver the water at all points and return pipes carry it back to the tank. Valves are so placed that any portion of the hydraulic machinery can be cut off without interference with the remainder of the system. An accumulator of small capacity is in connection with the supply pipes to receive any excess or supply any deficiency in the amount of water furnished by the pumps. It also automatically controls the speed of the pumps through a connection between the steam throttle and accumulator ram, such as to open the throttle as the ram falls, or close it as the ram rises.

The entire operation is automatic outside of the engine of the regulating mechanism, the direction and speed of which is so regulated as to give the desired direction and speed to the lift. When the engine is started for raising the lift, the valves open and water is drawn off from the accumulator. The ram of the accumulator falls and the steam-throttle of the pumps is opened until an equilibrium is established and water supplied in the quantity called for by the speed of the regulating mechanism. The entire operation is under the control of the regulating engine, of course within the limit of the capacity of the pumps.

The cradle is raised slightly above the track level and the regulating engine is stopped. The chocks are thrown in position beneath the cradle by operating the proper rams, and the cradle is gently lowered upon them by reversing the regulating engine.

To lower the cradle it is first raised sufficiently to clear the chocks, which are then withdrawn. The engine is reversed, winding the vertical shafts up through the sleeves. The valves are carried down, connections are made between the two ports, the water escapes from the presses back to the tank, and the rams descend under control as in rising. The operation is similar to that of raising the cradle, except that the pumps take no part in it, and the limit of the speed is fixed by the ability of the water to escape by the valves and pipes. Practically the speed in lowering is considerably greater than in rising.

The operation of the pumping plant and regulating mechanism is as follows: The lift being at rest, the position of the regulating valves is as shown on the drawing, the connection between the presses and both supply and return pipes are closed, and the pumps furnish water only to supply leakages. To raise the cradle, the engine of the regulating mechanism is so started as to wind the vertical screw-threaded shafts down through the sleeves on the ram-heads. The rams being at rest, the shafts are carried bodily downward; the slide-valves rise, uncovering the lower ports; water flows into the presses, and the rams move upward, carrying the cradle 4 ft. for 1 ft. This continues so long as the speed of the rams is the same as the speed with which the sleeves are wound upward on the shafts. If the speed of the rams is less than this regulated speed, the shafts are carried farther down, and the ports opened more fully. If the speed of the rams is greater, the shafts are carried upward, and the ports are partly closed. Should the load on any ram be less than on any other, the water will seek that press more freely, the ram will rise faster than the others and than the regulated speed, and will carry the shaft upward, partly or wholly closing the valve, which will be opened again when that particular ram is again in unison with the others. Similarly for an overloaded ram, the valve will be opened more fully.

The cradle and all the framed portions of the lift are of mild steel and calculated for a maximum strain of 10,000 lbs. per sq. in. Provision is made in the side trusses for carrying the load to the adjoining rams in case any one press is disabled. The weight of the cradle is 184 tons. The weight of the car is 300 tons and of the boat is 600 tons. Total weight suspended from chains, 1,084 tons, and average weight per ram, 67.75 tons. The weight of each ram and its attachments is 23.4 tons. The weights of car and cradle are uniform, but that of the boat is not. The same assumption on the distribution of its weight as was made in the calculations for the car gives as the maximum load suspended from the center rams 79.7 tons. The maximum total pressure on these rams is then four times the maximum suspended load, 79.7 tons, with an addition of 23.4 tons, the weight of the ram and fixtures. The total pressure is therefore 342.2 tons, and the pressure per sq. in. is 970 lbs. The speed proposed for the cradle is 4.5 ft. per minute, corresponding to a speed of 1.12 ft. per minute for the rams.

At any stage of the river all portions of the lifts for operating at that stage will be above the water, with the exception of the lower bearings of the vertical regulating shafts and portions of the rams, and of the supply pipes leading to the presses. The lower lift will be totally submerged only at extreme high water, a stage of short duration and very rare occurrence. The engine and boiler houses will be conveniently located and above extreme high water.

Each of the lifts is placed in a chamber excavated for it in the rock. A channel of 60 ft. bottom width leads from the river to the lift chamber. Estimates are made for a masonry pier 12 ft. by 6 ft., horizontal dimensions, to

support each ram, and also for masonry linings, for the vertical faces of the lifts.

CAPACITY OF THE SYSTEM.

This is limited by the capacity of the lower lift. The estimated time at extreme low water to raise one boat and lower another is as follows:

	Minutes.
For boat to enter lift chamber and make fast	5
For raising cradle to level of track	15
For hauling car from lift and substituting another car	5
For lowering cradle and for boat to leave chamber	10
Total for one complete manœuver	35

If this rate be maintained, the maximum capacity of the lift would be 20 boats each way in 12 hours, and 40 boats each way in 24 hours. To run the line to this capacity would require 6 cars and 12 locomotives, and a turnout at each lift for passing cars. With two lifts at each terminus the capacity could be doubled without any other change in the railway than the lengthening of the turnouts to pass two cars at once, trains being run in two sections.

The time required to pass the obstruction at extreme low water may be estimated as follows:

	Minutes.
To enter lower lift chamber and make fast	5
To raise cradle to level of track	15
To haul off lift, over railway, and on upper lift	60
To lower cradle of upper lift and for boat to leave chamber	10
Total	90

As the river rises the maximum capacity of the line increases and the delay at the lifts decreases. When the line is worked to its full capacity, however, there will be considerably greater delay at turnouts and at the lifts awaiting turn than that estimated above.

At the opening of the railway it is proposed to furnish two cars, four locomotives and one central turnout. This will give one car for service with a second in reserve for use in case of accident and will also give two cars and their motive power for occasional use. A single car will have a maximum capacity of 4 boats each way in 12 hours. The estimated cost of operation to pass 8 boats each way in 12 hours is estimated at $80,000 per annum. To double this capacity with the same equipment would pass 16 boats each way per day and cost $150,000; while to run at full capacity, passing 40 boats each way in 24 hours, would cost $275,000 per annum.

ESTIMATE OF COST.

Right of way	$ 5,000
Railway	1,480,231
Celilo lift	337,612
Big Eddy lift	361,295
2 Transport cars	116,640
4 Locomotives	60 000
Building	75,000
Tools and incidentals	10,000
Engineering and contingencies, 10%	244,577
Improvement of Three Mile Rapids	170,000
Aggregate	$2,860,356

The above estimate was made in detail for materials delivered on the site, and for constructions erected ready for operation.

A New Slope Stake Setter and Universal Slope Indicator.*

The accompanying figure represents a new time saving contrivance which will be found of great use by all those engaged in railway work. It serves two special purposes:

First.—By its means the exact point of intersection of the slope of an embankment or cutting with the natural surface of the ground, and consequently the position of the slope stakes, is immediately and accurately ascertained, and that without any calculations whatever.

Second.—The instrument gives instantly and also without any calculation, all the various dimensions of embankments or cuttings with varying ground surfaces and side slope ratios, from which the area of the cross section may be calculated in the simplest manner possible and in the shortest time.

The indicator consists of three flat pieces of wood, metal, Bristol board or other material, namely:

AA; the foundation plate with a central horizontal line and a central vertical line, both graduated to a convenient scale of feet. The point of intersection of these two lines represents the center line along the natural surface of the ground, whilst the center height is measured upward from the same on the vertical line.

BB; a vertical sliding piece representing the cross section of an embankment or cutting. This piece is interchangeable, so that it may suit different slope ratios and widths of roadbed. The slopes are graduated to the same scale of feet, as is also a vertical line drawn downward on each side of the roadbed, giving the height of each of its sides above the ground surface.

CC; a straight scale revolving upon the point *D* and representing the varying degrees of slope of the natural surface of the ground. This straight scale, which is graduated to feet right and left from its center, has fixed to its lower edge a semi-circular protractor, by means of which it may be set to any angle of slope.

These three pieces are kept in their respective positions by means of three small flatheaded screws with thumbnuts, the middle one, *D*, acting as a pivot upon which the straight scale *CC* can be turned round. In the sliding section *BB* are three slots, through which the screws pass, so that a vertical movement up or down can be given to this piece.

To use the indicator the sliding section is raised to the required center height, and the straight scale turned to the angle of slope of the surface of the ground; the point of intersection of each of the side slopes with the surface of the ground is then at once seen, and their respective distances from the center line easily read off, thus fixing without estimation or trial the exact position of the slope stakes. The length of each of the side slopes can also be at once ascertained if required. Thus in Fig. 2 the roadbed *ab* is assumed to be 18 ft. wide, and the height of the center line above the surface of the ground, or *dc*, is taken as being 12 ft., while the side slopes *Aa* and *Bb* are 1½ to 1, and the angle of the surface of the ground with the horizon is 10°. After setting the sliding piece *BB* to 12 ft. and turning the protractor to 10°, we at once see that *Ac* measures 37.2 ft. and *Bc* = 21.6 ft. These distances then measured out from *c* are the positions of the slope stakes.

When the surface of the ground presents a different slope on each side of the center line, the straight scale must be set first to one slope and the distance read off, and then to the other slope and its corresponding distance noted.

We have said that this instrument serves also to ascertain in a very simple manner the cross sectional area of an embankment or cutting. This may be done very quickly in the following way:

The side slopes of the sliding section *BB* are prolonged upward until they meet, as shown at *c* in Fig. 2, thus forming with the ground surface line a triangle *ABc*. A graduated square, which slides along the straight scale (kept in position by a slot, through which passes the pivot *D*) enables the length of the perpendicular *Cc* to be immediately noted. This distance, as shown in Fig. 2, is found to measure 17.8 ft. We then proceed as follows:

Ac, already ascertained	= 37.2
Bc, " "	= 21.6
Whence *AB*	= 58.8 ft.
Half of $Cc\left(\frac{17.8}{2}\right)$	= 8.9 "
Their product	= 523.32 sq. ft.

which is consequently the area of the triangle *ABc*. From this we now deduct the area of the small triangle *abc*, which is a constant for all roadbeds of the same width with the same side slopes, and is obtained by the formula $ab \times \frac{ab}{4r}$, where *r* is the ratio of the side slopes. In the present example this constant is $18 \times \frac{18}{4 \times 1\frac{1}{2}} = 54$ sq. ft., so that we have

	Area of triangle *ABc*	= 523.32 sq. ft.
Less	" " *abc*	= 54.00 "
	Leaves	469.32 "

as the area of the cross section *AabB*.

We append a list of constants *K* for different widths of roadbeds and various slope ratios to be used with the formula applying to the Indicator, namely:

Cross sectional area $AabB = (AB \times \frac{1}{2}\ Cc) - K$,

by means of which any area may be obtained in the shortest space of time possible.

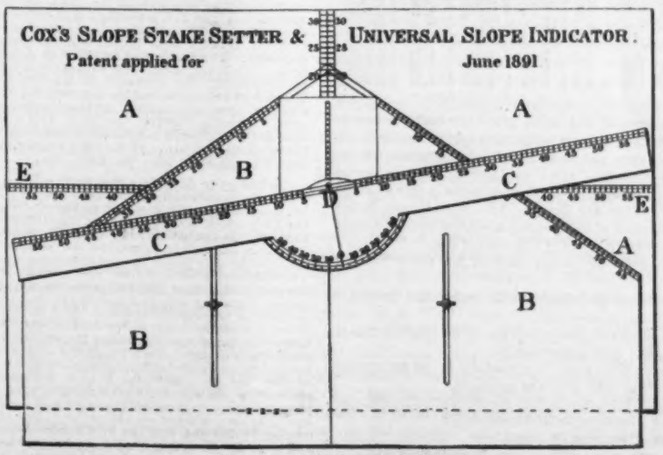
This instrument will be found specially useful for the purpose of making out preliminary estimates, from the facility and accuracy with which the various dimensions and areas may be obtained.

The slope stake setter and indicator, which is copyrighted and for which a patent has been applied, may be had of Keuffel & Esser Co., New York, the sole licensees.

TABLE OF CONSTANTS TO BE USED IN COX'S FORMULA.
Area = $(AB \times \frac{1}{2}\ Cc) - K$.

Slope ratio.	Width of roadway. 14 ft.	16 ft.	18 ft.	20 ft.	22 ft.	24 ft.	26 ft.	28 ft.	30 ft.	33 ft.
¼ to 1	196	256	324	400	484	576	676	784	900	1,089
½ to 1	98	128	162	200	242	288	338	392	450	544
¾ to 1	66	86	108	134	162	192	226	262	300	363
1 to 1	49	64	81	100	121	144	169	196	225	272
1½ to 1	33	43	54	67	81	96	113	131	150	182
2 to 1	24½	32	40½	50	60½	72	84½	98	112½	136

Other constants may be easily obtained by the formula $a\ b \times \frac{ab}{4r}$, or by interpolation, which gives results near enough for practical purposes.



Copyright, 1891, by William Cox.
Fig. 2.

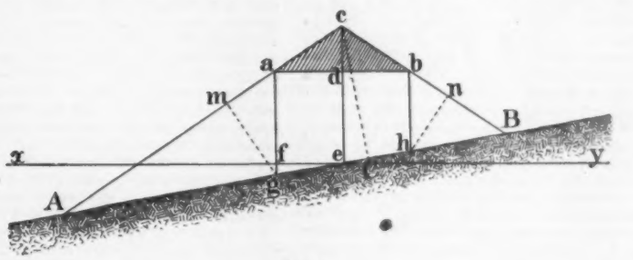


Fig. 2.

Electric Lighting by Municipal Authorities.*

The supply of electricity may be now regarded as one of the requirements of the day; and it is of first importance to municipal authorities to consider the expediency of preserving the supply in their own hands. Many have lost the opportunity, and have allowed companies to obtain powers over their areas. Many are now deliberating upon the point, or are in conflict with companies, and, as I think, the question is ripe for decision. I hold

* From *The Compass*, by courtesy of the editor, Mr. WM. COX.

* Read before the Incorporated Association of Municipal and County Engineers by HENRY ROBINSON, M. I. C. E.

that it is not so advantageous for these undertakings to be carried out by private enterprise and by outside capital, as it is by capital raised on the rates, whether from a financial or public point.

When Mr. CHAMBERLAIN, as President of the Board of Trade, was engaged in 1882 in the lengthened inquiry on the subject of electric lighting (which resulted in the act of the year), an organization composed chiefly of delegates of the principal municipal corporations urged upon the Board of Trade the necessity for entrusting the supply of electricity to local authorities in preference to companies, in order to avoid the creation of another monopoly like gas and water, and to ensure the profits of the undertaking being secured to the ratepayers instead of to outside companies. A prominent part was taken in the action of that time by Mr. T. ECCLESTON GIBB (the Vestry Clerk of St. Pancras), whose judgment and experience in affairs relating to municipal government are probably second to none in the kingdom. He held the strong opinion that the authority should keep the powers in their own hands; and Dr. HOPKINSON, F. R. S., and myself were consulted at that time with a view to this policy being pursued in the St. Pancras District. The result was that a Provisional Order was obtained in 1883, by which all the companies were, and have been ever since, excluded from this district; and in this respect St. Pancras has been an exception to the rest of the Metropolis in having acquired these powers.

In the year 1888, an amending act was passed, under which many of the onerous conditions were removed, and by which the monopoly acquired by any company was extended to 42 years. By this time numerous able and enterprising inventors had been devoting themselves to perfecting the machinery for producing the supply of electricity, and of the methods of distributing it. The time had then arrived when a public body need no longer hesitate to engage in the business; and from the points of view of finance and general convenience, it was most desirable for the business to be undertaken by the authority. As regards finance, the authority can provide the necessary capital at a far lower rate than the company can, and to the convenience, the public lighting of the streets, the disturbance of roads, and the sanitary advantages of substituting electric light for gas in dwellings, point to their being matters that clearly devolve on the authority to deal with. The wide field that is open for the employment of electrical energy for motive-power, traction and public lighting purposes, is also a further reason for the supply being in the hands of the authority.

I think it will be useful to put on record in your "Proceedings," calculations that I have made of the relative cost of gas and electricity which have appeared in various reports of mine, when advising on the subject of electric lighting.

TABLE SHOWING COST OF GAS LIGHTING.

Description of burner.	Candle-power.	Consumption of gas per hour per lamp.	Candle power per ft. per hour.	Cost per hour, in pence, with gas at 2s 9d. per 1,000 ft.	
				Per lamp.	Per c. p.
		Ft			
Ordinary batswing	10	4.3	2⅓	0.142	0.0142
Flat flame, from	11.3	4.6	2½	0.152	0.0132
Flat flame, to	13.8	4.6	3	0.152	0.0110
Flat flames in clusters,	60	15.0	4	0.495	0.0083
Flat flames in clusters,	90	20.0	4½	0.660	0.0073
Flat flames in clusters,	150	30.0	5	0.990	0.0066
Special form (requiring motive power)	20	10.0	12	0.330	0.0028

On an average, it may be assumed that each private lamp in London will be used for 1½ to 2 hours per day throughout the year; while in the suburbs it will be used 1 to 1½ hours per day. In shops open till 9 o'clock, each lamp will be used 3 hours per day, and for public houses, restaurants, etc., each lamp will be used 4 to 5 hours per day throughout the year.

The annual cost of gas would thus be in a private house with 30 lights, used on an average 1½ hours a day, or 547 hours per annum:

	£	s.	d.
547 × 30 = 16,410 lamp-hours at 0.153d.	10	7	11
Add for rent of meter	0	14	0
Annual cost	11	1	11

The cost of gas piping and ordinary (not ornamental) fittings may be taken as follows:

	Per light.
Workshops and factories	2s. to 25s.
Shops	25s. to 35s.
Private houses (with 20 to 40 lights)	3s. to 40s.

It has been feared that gas properties will be injuriously affected by the general introduction of electric lighting; and this feeling has influenced some municipal authorities who own gas works either to oppose electric lighting orders or to secure them with a view to their not being acted on. I think the apprehension of gas properties being injured is exaggerated. There is an increasing demand for gas for warming, for cooking, for motive power and for other purposes, which makes it quite possible that the consumption of gas in the future may not be so diminished as is feared.

I will next give the result of my calculations and experience as to the cost of electricity. In a private house with 30 lights used on an average 1½ hours a day, or 547 hours per annum, the total lamp hours will be 16,410 per annum, as before. In order to compare with the estimate for gas previously given, 12½ c. p. may be taken as the average for each lamp (some being 10 and others 16 c. p.).

The actual cost of producing a Board of Trade unit of electricity may be taken at about 2¼ pence, excluding the provision for the sinking fund, or 3½ pence per unit including that provision. At the rate of 3½ pence per unit the cost would be as follows:

0.0135 × 1½ = 0.169d. per lamp hour, including renewals.

	£	s.	d.
16,410 lamp hours at 0.169d.	11	11	1
Add for rent of meter	0	14	0
	£12	5	1

If the current is charged at 6 pence per unit (which is lower than most companies charge and will yield a profit to the authority) the cost per candle power per hour will be about 0.022 pence per lamp hour or 0.275 pence, including renewals, in which latter case the cost of the 12 c. p. lamp would be £19 10s. per annum instead of £12 5s. 1d.

The cost of ordinary fittings for electric light will be for:

	Per lamp.
Workshops and factories	25s. to 30s.
Shops	30s. to 0s.
Private houses (with 20 to 40 lights)	35s. to 45s.

There are several advantages in employing electricity instead of gas to which it is difficult to assign a money value. For instance, the whitewashing, painting and papering of rooms would be seldom necessary when electric lighting is employed; the vitiation of the air by gas would be obviated, with good sanitary results, and the risks of fire would be diminished. In comparing the respective cost of gas and electricity the lamp hours are calculated as the same in both; whereas I think it will be found to be less with electric lights, as a light or a series of lights are switched on and off so easily that it is found the light is more frequently turned off when it is not wanted than is the case with gas. Where delicate textile fabrics and decorative or artistic goods are exposed it is found that the substitution of electric light for gas is attended with great advantage as regards their preservation, and also in enabling colors to be matched. Electric light is preferred to gas where wines, beer, etc., are stored, as it preserves the cellars and vaults cool.

I will next deal with public lighting, which concerns municipal authorities very closely. For street lighting the arc lamp is the most economical. The smallest size of arc lamp at present manufactured requires a current of about 5 amperes; but for steadiness and efficiency it is desirable not to use less than 6 amperes. The candle power of arc lamps varies considerably, according to the angle at which it is measured. The greatest intensity with continuous current lamps is found at an angle of about 40° below the horizontal line. The following table gives the approximate candle power at various angles. The height of the lamps should be arranged so as to give an angle of not less than 7° to the most distant point it is intended to serve.

LIGHTING POWER OF ARC LAMPS.

Current in amperes.	CANDLE-POWER. Horizontal.	At angle of 7°.	At angle of 10°.	At angle of 20°.	Maximum at angle of 40°.
6	92	175	207	322	460
8	156	300	350	546	780
10	220	420	495	770	1,100

The following table gives the cost in pence of working arc lamps:

Current in amperes.	Average c. p. at angle of 20°.	Watts required.	Units used per hour.	Cost of current at 3½d. per unit.	Cost of carbons 0.506, and fixing 0.164.	Total cost per lamp-hour.	Cost per average c. p. per hour.
6	322	360	0.3	1.05	0.66	1.71	0.00531
8	546	480	0.4	1.40	0.66	2.06	0.00377
10	770	600	0.5	1.75	0.66	4.21	0.00313

The last column in the table gives the cost per candle power per hour; and these figures are arrived at by dividing the "total cost per lamp hour" by the figures representing candle-powers "at an angle of 20°" (given in the table of lighting-power) which represents a fair average of the power from arc lamps. The last column in the table of cost admits of comparison with the last column of the table previously given of the cost of gas.

Arc lights should be placed high up for the following reasons:

(1) On account of their high candle power and great distance apart.

(2) Because the light thrown down at an angle is much greater than that cast horizontally.

(3) Because the light given horizontally is not so steady as that which is thrown down at an angle.

The following data enable the co-efficient of minimum lighting-power in streets to be determined:

Let P = candle-power of lamps.

L = maximum distance from lamp in feet.

H = height of lamp in feet.

X = a co-efficient.

The light falling on the unit area of pavement varies inversely as the square of the distance from the lamp, and is directly proportional to the angle at which it falls. This angle is nearly proportional to the height of the lamp divided by the distance. Therefore

$$X = \frac{P}{L^2} \times \frac{H}{L} \quad \text{or} \quad X = \frac{PH}{L^3}.$$

The usual standard of gas-lighting is represented by the amount of light falling on the unit area of pavement 50 ft. away from a 12 c. p. gas lamp 9 ft. high which gives a co-efficient as follows:

$$X = \frac{12 \times 9}{50^3} = 0.000864.$$

Adopting the above co-efficient, I calculated that the before-mentioned sizes of arc lights will give the same standard of light at the heights and distances stated in Table A:

TABLE A.

Height of lamps	20 ft.	25 ft.	30 ft.	35 ft.
Current in amperes.	Maximum distances served from lamp.			
6	160 ft.	175 ft.	190 ft.	202 ft.
8	185 "	202 "	220 "	235 "
10	205 "	225 "	243 "	260 "

Table B gives the corresponding distances, assuming the minimum standard to be adopted, thus bringing the co-efficient up to .001728, which represents the amount of light on a unit area 50 ft. away from a 24 c. p. lamp 9 ft. high.

TABLE B.

Height of Lamps	20 ft.	25 ft.	30 ft.	35 ft.
Current in Amperes.	Max. distances served from lamp.			
6	130 ft.	144 ft.	155 ft.	166 ft.
8	150 "	165 "	180 "	193 "
10	170 "	190 "	205 "	220 "

The distances the lamps are apart would, of course, be double the distances mentioned in Tables A and B. One arc lamp will take the place of from 3 to 6 gas lamps, according to the locality, arrangement and standard of light adopted. A scheme of arc lighting, based on the substitution of one arc light on the average for 3½ to 4 gas lamps, would double the minimum standard of light, while the average standard would be increased 10 or 12 times.

Legal Decisions of Interest to Engineers.

Death of Brakeman by Lack of Deadblock.—A trestle on a coal wharf had nothing to prevent cars from running off the end but a log chained to the track. The company had ordered a substantial deadblock put in, but this had been neglected for a period of four years. The company is liable in damages for the death of a brakeman resulting from a car going over the end of the trestle. Norfolk & W. Ry. Co. v. Gilman, Supr. Ct. App. of Va., 13 S. W. Rep., 475.

Failure to Fence Railway Tracks. Under a statute requiring railway companies to inclose their tracks, and declaring them liable in case of failure to do so for injuries to stock which shall stray upon the track, it is no defense to an action for injuries to stock that the land on either side of defendant's track was occupied by the tracks of other railway companies. The responsibility of the company is absolute unless the statute has been specially complied with. Kelver v. N. Y. C. & St. L. Ry. Co., Sup. Ct of Buffalo, 12 N. Y. Supp., 322.

Injury for Defective Track.—In an action for an injury to an engineer alleged to have resulted from defects in the track, there was evidence that he was running at a speed in excess of that allowed by the rules of the road. The defendant requested a charge that the burden was on the plaintiff to show that he was not acting negligently in the rate of speed at which he was running. The charge requested was misleading, in that the jury would have understood that the defendant was entitled to a verdict if the engineer was running at a greater speed than was prudent, though that might not have contributed to the accident. The train was running in front of the locomotive. While the track was defective, it was not so much so as to justify the engineer in leaving his employment. There was evidence that he was running at a rate of speed directed by special order. If there was negligence on his part, its degree was for the jury, and it was not error to charge that it would not defeat a recovery unless he failed to use ordinary care. (Texas & Pac. Ry. Co. v. Geiger, Sup. Ct. of Texas, 15 S. W. Rep., 214.)

Liability for Defective Sidewalk.—In an action against a city for personal injuries sustained by plaintiff by having her foot caught in a hole in the sidewalk, evidence of the long continued existence of the defect is admissible to show notice thereof to defendant, though it shows the existence of the defect before the law went into effect, which renders the city liable for the injuries occasioned thereby. The evidence showing that there were several holes in the sidewalk where plaintiff was injured, and certain witnesses not being able to identify the hole into which she stepped, it is not error to allow them to testify as to all the holes, where the court afterward charges the jury that plaintiff cannot recover unless the city had notice of the identical hole into which plaintiff stepped, and the existence of other holes cannot be used to show the existence of the one in question. Where defendant requests a charge that if the Street Commissioners shortly before the accident, went over the sidewalk, and examined it carefully, and did not see this defect, then he used requisite care and diligence, and the city is not liable, it is proper to add that the jury may consider the testimony as to the previous existence of the hole in determining whether he did use due care in his examination. (Tice v. Bay City, Sup. Ct. of Mich., 47 N. W. Rep., 1,062.)

The Efficiency of Steam Separators.

A test of the efficiency of six steam separators of different styles was recently made at Sibley College, Cornell University, under direction of R. C. CARPENTER, Professor of Experimental Engineering. The use of separators, especially with high speed engines or with engines located at a considerable distance from the boiler, is becoming increasingly common; but very little is known as to the comparative efficiency of the different makes.

The separators tested were attached to a steam pipe supplying a 20 HP. Straight Line engine; and to secure sufficient moisture in the steam for the purposes of the test, a section of the pipe was covered with a water jacket. The flow of steam was made uniform by keeping a constant load upon the engine. The test of each separator consisted in passing the steam for the engine through it, testing its percentage of moisture before entering the separator and after leaving it.

The percentage of moisture was determined in most cases by a universal calorimeter designed by Prof. CARPENTER; but in a few cases a throttling calorimeter designed by a student of Cornell University was used. The runs were each 20 minutes in length and the gages and thermometers were read at intervals of 5 minutes.

The object of the tests was to determine the principles involved in so constructing separators as to secure the greatest efficiency; and the names of the different separators tested were not published, the different styles being designated by the letters A to F. The tests showed that with such an amount of moisture in the steam as is common in ordinary practice, there was a great difference in the efficiency of the several makes. The following table shows the efficiencies of the various separators with steam containing various percentages of moisture.

Make of sep'rat'r.	Qual. of steam before.	Qual. of steam after.	Effic'ncy per cent.
DRIEST STEAM.			
B	97.5	99	60
D	96.1	97.4	33.3
E	98.1	98.5	21.1
F	97.7	97.9	8.7
C	95.6	95.8	4.5
A	98.0	98.0	0.
STEAM WITH ABOUT 10% OF MOISTURE.			
B	87.0	98.8	90.8
A	90.1	98 0	80.0
D	89.6	95.8	59.6
C	90.6	93.7	33.0
F	88.9	92.1	28.8
E	88 4	90.2	15.5
STEAM WITH ABOUT 20% OF MOISTURE.			
B	78 1	98.8	94.5
A	79 5	98.2	91.2
D	81.7	97.9	83.5
C	78.2	9[illegible].6	79.8
E	82 4	90.4	45.5
F	79.3	87.2	38.1

Of course a certain amount of the variations noted in the above tables were due to imperfections in the calorimetric measurements and variations in the quality of the steam. On the whole, however, the tests were conclusive in showing a marked difference in the efficiency of the different separators. The summary of the results was as follows, taking the different separators in the order of their efficiency:

Separator B.—With steam varying in quality from 66.1% to 97.5% the separator furnished steam varying from 97.8% to 99%. The average efficiency was 87.6%.

Separator A.—With steam varying in quality from 51.9% to 98% the separator furnished steam varying from 97.9% to 99.1%. The average efficiency in 12 tests was 76.4%.

Separator D.—With steam varying from 72.2% to 96.1%, the separator furnished steam varying from 95.5% to 98.2%. The average efficiency in 10 tests was 71.7%.

Separator C.—With steam varying in quality from 67.1% to 96.8% the separator furnished steam varying from 93.7% to 98.4%. The average efficiency in 12 tests was 63.4%.

Separator E.—With steam varying in quality from 68.6% to 98.1%, the separator furnished steam varying from 79.3% to 98.5%, the separator seeming unable to remove the moisture very thoroughly from the samples of steam having more than 10% of moisture. The efficiency in 10 tests averaged 36.9%.

Separator F.—With steam varying in quality from 70.4% to 97.7% the separator furnished steam varying from 84.1% to 97.9%. The wet samples of steam were not thoroughly dried by this separator. The average efficiency in 10 tests was 28 4%.

We quote as follows from the report of the tests as published in *Power*:

The volume of each of the separators was determined by filling with water, we expecting to find that to a certain extent, at least, the efficiency of separation depended upon the volume. We found no such relation existing, owing undoubtedly to the various modifying conditions arising from the several characteristics of the different forms.

No marked decrease in pressure was shown by any of the separators, the most being 1.7 lbs. in E and ranging from this to 0.6 lbs. in B.

Our investigation has led us to believe, and the results when taken in connection with the forms of separators clearly show, that although changed direction, reduced velocity and perhaps centrifugal force are necessary for good separation, still some means must be provided to lead the water out of the current of the steam.

If such provision is not made, momentary separation may occur; but before the water can drop or run from any surfaces in the direct current it will be again taken up by the rapidly moving steam which continually surrounds it. We believe that the high efficiency obtained from *B* and *A* was largely due to this feature. In *B* the interior surfaces are corrugated and thus catch the water thrown out of the steam and readily lead it to the bottom.

In *A*, as soon as the water falls or is precipitated from the steam, it comes in contact with the perforated diaphragm through which it runs into the space below, where it is not subjected to the action of the steam.

In *D*, the next in efficiency, this is accomplished by means of a >-shaped diaphragm which throws the water back into the corners out of the current of steam.

In reality *E* depends for its action upon a pendent diaphragm placed across a greatly enlarged section of a horizontal pipe. With a good quality of steam this separator showed a very fair efficiency; it, however seemed to be unable to handle steam with more than 10% moisture. We believe that this inefficiency is due to the fact that the water has no means of escaping from the direct action of the steam.

In *F* separation is claimed to be accomplished by centrifugal action. We have no doubt but that centrifugal action does take place, but there are no means provided for throwing the water beyond or out of the presence of the steam. Undoubtedly a constant whirl of mixed water and steam is maintained within the separator. Indeed, our engineer stated that he had had steam blowing freely from the drain while the water glass was full of water. This would seem to indicate pretty clearly the existence of a solid layer of water about the walls of the separator while the central portion was comparatively free. In our judgment this separator would become much more efficient were the inner surfaces provided with corrugations for breaking up this whirlpool-like action after the initial separation takes place.

As a result of our investigation we have ample reason to conclude that steam separators may be constructed which will furnish a uniformly good quality through as great a variation in quality as will be found in any practice. We believe that we have fully established the principles to be followed in construction and operation of such a separator.

Tests of Manganese Bronze.

The last report of the Chief of the Bureau of Steam Engineering, U. S. Navy, describes tests of the strength of some specimens of manganese bronze, cut from the pouring gate for the hub of the propeller for the U. S. Steamer *Maine*. Transverse, crushing, and torsional tests of these specimens were made at the New York navy yard. The specimens for transverse test were nominally bars of 1 in. square cross section. Their actual dimensions were about .01 in. greater. The points of support were 10 ins. apart and the load was applied at the center. The increment of load was 200 to 300 lbs. with the first specimen and 500 to 1,000 lbs. with the second. Permanent set was first noted with a load of 1,000 lbs., amounting to .007 in. With a load of 3,000 lbs. the first specimen showed a total deflection of 0.752 in. and a permanent set of 0.567 in. The second specimen showed under this load 0.644 in. deflection and 0.479 in. permanent set. The first specimen deflected 2.022 ins., and broke at a load of 6,300 lbs. The second specimen deflected 2.483 ins., and broke at 6,450 lbs.

The maximum fiber strain in the specimens at the breaking point was computed to be 82,150 lbs. per sq. in. for the first specimen, and 84,530 lbs. per sq. in. for the second specimen. This was computed by the formula for beams loaded at the center and supported at the ends:

$$mWl = nfbh^2$$

Where $m = \frac{1}{4}$ and $n = \frac{1}{6}$; $l = 9$ ins., the distance between the points of support when the specimen broke; b and h, are, of course, the dimensions of the cross-section; W is the load, and f, the fiber strain per square inch.

In the crushing tests, two specimens 1 in. high and 0.7×0.7 in., cut from the pieces broken in the tests above described, showed a crushing strength per sq. in. of 126,450 lbs. and 135,750 lbs., respectively. Both specimens failed by shearing on a plane making an angle of nearly 45° with the direction of the stress.

Subsequently an inch cube, cut from metal which had not been subjected to strain, was subjected to a load of 150,000 lbs., which flattened it to 0.72 in. high and 1¼ in. square, but without rupture or any sign of distress; borings showed the interior to be homogeneous and without flaws.

The torsion tests were made on one rolled rod and one cast rod, each 1¼ ins. in diameter at the ends, and turned down to ⅝ in. diameter for a length of 4 ins. One end was held fast and a 48-in. lever was so attached as to tend to rotate the other end. The rolled specimen broke with a weight of 115 lbs. on the end of the lever, or a total moment of torsion of 5,520 inch-pounds. The cast specimen broke with a load of 180 lbs. on the end of the lever, a total moment of torsion of 8,640 inch pounds.

The rolled specimens, however, showed much greater resilience than the cast. The former was twisted 343° and the latter 192° when rupture occurred.

Tests of the Worthington High Duty Pumping Engines at Memphis, Tenn.

In our issue of Aug. 17, 1889, we illustrated the new pumping plant installed by Henry R. Worthington for the Artesian Water Co. Memphis, Tenn. The terms of the contract provided that each engine should be subjected to a joint trial for capacity and duty under the direction of three experts, one selected by each of the contracting parties and the third to be agreed upon by the first two. The test was conducted by Messrs. J. J. DE KINDER, expert selected by the Artesian Water Co., A. J. CALDWELL, representing HENRY R. WORTHINGTON, and Mr. CHAS. B. BRUSH. We abstract their report as follows:

REQUIREMENTS OF CONTRACT.

Pumping Engines.—Three vertical, direct acting pumping engines to be furnished, each to have a capacity of not less than ten million U. S. gallons in 24 hours against a head of 250 ft. of water, this capacity to be obtained with a pump plunger speed of not more than 150 ft. per minute, and cylinder capacity to be sufficient to do the work with a steam pressure of 100 lbs. per sq. in. The duty developed on trial must be not less than 105,000,000 ft. lbs. for each 1,000 lbs. of steam at 110 lbs. pressure, the steam to be taken as furnished to the engine by the boilers and fixtures furnished by the contractor.

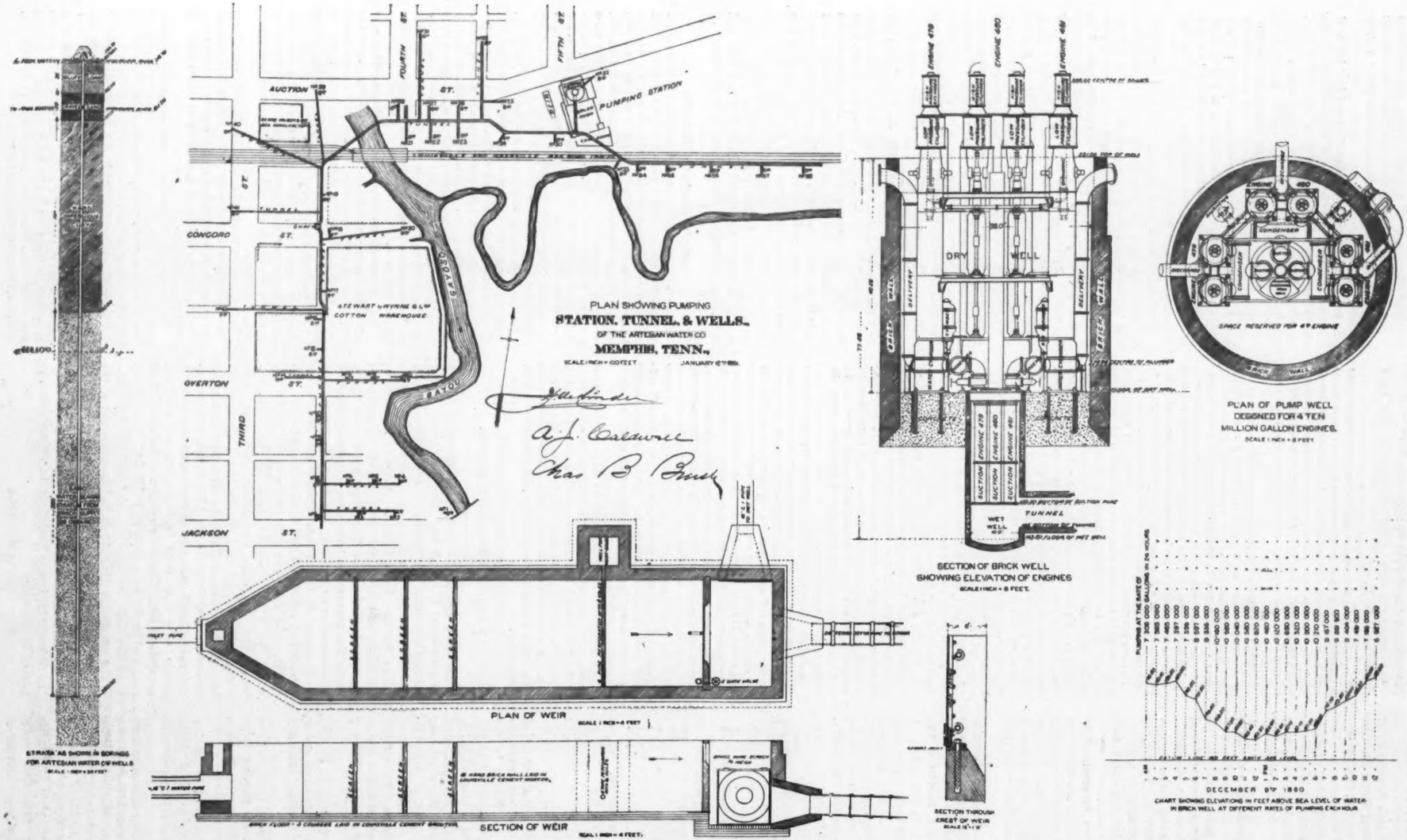
Boilers.—Six steam boilers to be furnished of such capacity that any two of them with economical firing will furnish ample steam to work one pumping engine at the capacity above noted, the steam pressure in the boiler being 110 lbs. per sq. in. At the time of test the boilers must develop an evaporative efficiency of not less than 10 lbs. of water from and at 212° Fahr. per lb. of coal. The best Youghiogheny second pool Pittsburg coal to be used as the standard, and steam pressure to be carried at about 110 lbs. per sq. in.

Test.—In testing the boilers the experts may select any pair of boilers they may desire. Steam will be raised to the proper working pressure with clean fires of usual thickness. From this time the quantity and temperature of water put into the boiler shall be accurately measured and all coal used shall be charged to the boilers without deductions of any kind. The test shall continue not less than 24 hours; and at the close the fire and the water in the boiler shall be in the same condition as at the beginning of the trial.

In testing the pumping engines, the mode of determining the foot pounds of work done shall be left to the experts. The steam is to be measured by the quantity of water delivered to the boilers. The capacity required shall be reached in the test.

The contractor is to guarantee the machinery and appurtenances for two years after their acceptance from all loss or damage arising from defective materials or faulty workmanship or design.

The boilers were furnished by the Heine Safety Boiler Co., and their contract with Henry R. Worthington provided that each of the boilers should be capable of evaporating 4,700 lbs. of water per hour into dry steam at a gage pressure of 110 lbs. per sq. in., also that each should be capable of evaporating 4,760 lbs. of water per hour from and at 212° Fahr. with a coal expenditure of 1 lb. for 10 lbs. of water, fuel to be as specified above.



PUMPING STATION, TUNNEL AND WELLS OF ARTESIAN WATER CO., MEMPHIS, TENN. (The Late Thos. J. Whitman, Consulting Engineer.)

DESCRIPTION OF WATER SUPPLY AND SURROUNDINGS.

The water supply of Memphis was formerly taken from the Wolf River, a tributary of the Mississippi, just north of Memphis. Investigations made by Mr. R. P. GRAVES, now Vice-President of the water company, developed the fact that a large subterranean supply of water existed under the city.

As the Wolf River supply was not satisfactory, the late THOS. J. WHITMAN, Civil Engineer, was retained as consulting engineer, and the present works were built under his direction. The work was practically completed before the death of Mr. WHITMAN in 1890.

The water is pumped from the large brick well, as shown in the accompanying illustration. This brick well is supplied with water through a brick tunnel 5 ft. in diameter from 41 tube wells. The connection between the tunnel and the brick well is 6 ft. in diameter. Ten of these wells as shown are 6 ins. in diameter, and 31 of the wells are 8 ins. in diameter. These wells range from 260 to 480 ft. in depth, the majority ranging from 350 to 400 ft. They extend into the water bearing stratum from 80 to 130 ft. The above dimensions include the strainer, which is ½ in. less in diameter than the casings. The area of the perforations of the strainer is 10 times the area of the cross section of the tube.

From the pump house the distance to the most westerly well is about 850 ft., to the most southwesterly well 1,250 ft., to the most easterly well 600 ft., and to the most northwesterly well 410 ft. These distances were measured in a direct line.

The water bearing stratum is about 700 ft. in depth. It is composed of white sand of various sizes, but most of this sand will pass through a screen of 2,500 meshes per sq. in. Scattered through this sand are found beds of clay from 1 to 3 ft. in thickness.

At Greenville, 125 miles south of Memphis, this bed of sand is encountered about 50 ft. lower than at Memphis; at Vicksburg, 200 miles south of Memphis, a boring 800 ft. in depth, failed to strike this sand stratum. It is believed that this sand stratum curves to the east after passing Greenville, and continues to the Atlantic Ocean at some point near Savannah, a distance from Memphis of about 750 miles.

This water bearing stratum of sand 700 ft. thick is found underlying the Memphis region. The top of the stratum at Memphis is 35 ft. above sea level and 150 ft. below low water in the Mississippi River. This sand has a stratum of impervious clay 150 ft. thick above it, which acts as a cover to retain the water and exclude all impurities. The water obtained from this sand bed has no connection with the surface about Memphis nor with the water of the Mississippi and Wolf Rivers. The water rises from this

sand to a level 7 feet above high water in the Mississippi. The drainage area which supplies the water to this sand stratum is probably a belt of hilly country from 50 to 80 miles easterly from Memphis. From this belt the slope is gradually westerly and northwesterly to the Mississippi River. The beds of the largest streams of this belt are from 10 to 200 ft. above high water at Memphis, while the smaller streams are still higher.

During the test engine No. 479 pumped against a partially closed gate on the delivery main, and all the water pumped by this engine was allowed to flow over a weir. During the test, also, engine No. 481 pumped water in the distribution pipes of the city. Both engines, of course, drew their supply from the same brick well.

While the quantity of water pumped by both engines

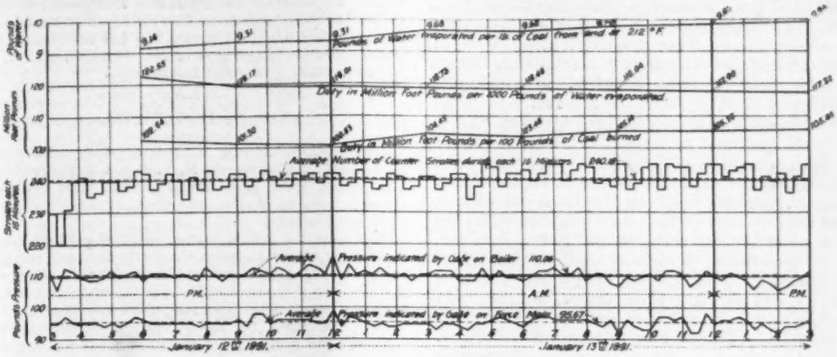

Pounds of Water evaporated per lb. of Coal from and at 212° F.
Duty in Million Foot Pounds per 1000 Pounds of Water evaporated.
Duty in Million Foot Pounds per 100 Pounds of Coal burned.
Average Number of Counter Strokes during each 15 Minutes.
Average Pressure indicated by Cards on Boiler.
Average Pressure indicated by Cards on Back Main.
A.M.
P.M.
January 12th 1891.
January 13th 1891.

DIAGRAM OF RESULTS OF TESTS.

during the 24 hour test amounted to nearly 20,000,000 galls., the net amount drawn from the well probably did not exceed 8,000,000 galls. The principal amount of the water that passed over the weir was returned to the brick well, and only a small portion of the surplus passed off through a sewer.

The water in returning from the weir to the brick well carried air down with it. Some of this air was caught by the current passing into the suction pipe of the engine and drawn up into the pump cylinders. All connection between the portion of the plant tested and the balance of the plant was entirely cut off.

The average elevation of water in the brick well during the test was 170.17 ft. above sea level. The average elevation of the water in tube well No. 30, distant 128 ft. from the brick well, was 170.78 ft., in tube well No. 18, distant 978 ft., it was 171.07 ft., and in tube well No. 7. distant 1 643 ft., the average elevation of the water was 171.63 ft. These distances were measured along the pipe line.

The illustration shows the elevations of water in the brick well each hour during 24 hours, while the engine was pumping therefrom at different rates of speed, ranging from 6,927,000 to 10,980,000 galls. per day. These data were obtained by Chief Engineer E. J. COOLEY on Dec. 9, 1890, about one month prior to our test.

DESCRIPTION OF ENGINES.

The engines are compound, duplex, condensing, high-duty engines of the vertical type. The steam cylinders are jacketed on both sides and ends. Each engine has a separator in steam pipe directly over main throttle valve. The exhaust from high pressure cylinders passes through a reheater to the low pressure cylinders. The water from the separators, reheaters and jacket drains is collected in a tank and returned to the boilers by a small independent pump. During the test the water from jackets, reheaters and separator was measured, but not returned to the boilers supplying steam for the engine being tested. The condenser is of the surface-condensing type located in the suction pipe of the engine, with an independent air pump for removing the vapor and condensed steam. The steam valves of both the high and low pressure cylinders are of the semi-rotating, cylindrical form, and are operated as usual in the duplex form of engine. The cut-off valves are similar to the steam valves, and are operated by direct link connections easily adjusted, each side of the engine driving its own cut-off valves.

The pumps are double acting, having 28 suction and 28 delivery valves for each plunger displacement. The valves are of the disk pattern, 4¾ ins. diameter, and have a lift of 5-8 in.

Each side of the engine is provided with a balancing device by which the loads on the up and down strokes are equalized. This device consists of a plunger attached directly to the engine cross-head, the plunger working in a cylinder filled with water. This cylinder is connected by pipes with an air tank which is kept filled with air under pressure. [For description of the "high duty" attachment to Worthington engines, see ENGINEERING NEWS, Nov. 6, 1886 and Aug. 31, 1889.—ED.]

DESCRIPTION OF BOILERS.

The boilers are of the ordinary water tube type, built under the patents of the Heine Safety Boiler Co. They have a long cylindrical drum, set with the rear end 13 in. lower than the front, from which, at either end, are hung two deep and broad water legs strengthened by hollow stay-bolts, and gathered together and narrowed at the top, where they are flanged on to the cylindrical drum. The boiler tubes, of ordinary type are expanded into the inner sheets of the water legs, and connect the one water leg with the other. Opposite the opening of each of the water tubes on the outside sheet of the water leg are placed handhole plates, which can be removed for inspecting and cleaning tubes. The furnaces, which are of the ordinary type, and the boilers are inclosed in a setting of brick. The gases pass from the grate backward over the bridge wall to the rear of the boiler, where they are deflected by means of tiles placed among the tubes, and carried upward again through the tubes to the front end of the boiler. Here they are again deflected and carried back along the surface of the cylindrical drum, passing out into the flue at the rear end of the setting. The water in the boiler circulates from the front of the cylindrical drum backward to the rear of the boiler, where it passes downward through the rear water leg, there turning and coming forward through the tubes and rising in the front water leg. A deflection plate is placed over the opening of the front water leg to prevent the possibility of water splashing upward and being caught by the current of steam passing to the engine. The boilers are furnished with the ordinary fittings common to all well appointed boiler plants, and are supplied with feed water by means of two independent feed pumps, either of which has sufficient capacity to supply the plant.

METHOD OF TEST.

The test was made on engine No. 479 and boilers No. 1 and 3 and continued from 3 P. M. Jan. 12, to 3 P. M. Jan. 13. All the water used, whether by boilers, separators, steam jackets or heaters was charged against the plant. The water was first weighed in tanks and afterwards measured by meter. The temperatures were taken and proper allowance made therefor. At 15 minute intervals the length and number of strokes, the steam and water temperatures, the draft, and the meter reading were recorded Seventy three indicator cards were taken during the test, and calorimeter tests of the steam were made from time to time. Gages and thermometers were tested with instruments that had been standardized by Schaeffer & Budenberg of New York City and by the Stevens Institute. All scales were tested before and after the trial with standard weights.

The result of the tests as given are those obtained after correcting the readings. The tables and constants used were obtained from the 1890 edition of D. K. CLARK'S "Manual."

BOILER TEST.

Area of grate surface	22.40 sq. ft.
Heating surface	1,020 sq. ft.
Ratio heating surface to grate surface	45 54
Area of air spaces in grate	11.20 sq. ft.
Area of cross-section of chimney flue	23.76 sq. ft.
Ratio of chimney flue to grate air space	2.12
Height of brick chimney	134 50 ft.
Force of draft in inches of water	0.80 ins.
Average temperature of boiler room	73.48°
" " escaping gases	493.2°
" " feed water	153.27°
" " steam	344.6°
Average pressure of steam by gage	110.06 lbs.
Quality of steam	Dry
Water evaporated per lb. of dry coal from actual temperature and pressure	9.02 lbs.
Equivalent evaporation per lb. of dry coal from and at 212° Fahr	9.94 lbs.
Equivalent evaporation per lb. of combustible from and at 212° Fahr	10.459 lbs.
Number of lbs. of coal required to supply 1,000,000 British thermal units, by analysis	77.50 lbs.
Number of lbs of coal required to supply 1,000,000 B. T. U., as determined from water evaporated	104.05 lbs.
Efficiency	74.5
Dry coal burned per sq. ft. of grate surface per hour	23.53 lbs.
Water evaporated from and at 212° per sq. ft. of heating surface per hour	5.14 lbs

Tests by the St. Louis Sampling & Testing Works showed that the coal used was 5½% lower in calorific value than the coal named as standard in the contract; hence the evaporation of 9.94 lbs. of water from and at 212° per lb. of coal was accepted instead of 10 lbs., as called for by the contract. Correcting for the amount by which the coal fell below standard, the evaporation becomes nearly 10½ lbs of water per lb. of coal. The coal was brought from the mines on open boats exposed to rain and snow, and was used as delivered. The moisture was determined by placing a quantity in a box and letting it stand over the boilers for 24 hours, then noting the loss in weight. The water of condensation from separators, steam jackets and heaters amounted to 9.48% of the total feed water. The steam pipe connecting the engines and boilers was 150 ft. in length.

ENGINE TEST.

Cylinder diameters: h. p., 30 in.; l. p., 60 in.; water, 27 in.	
Length of stroke: nominal, 4 ft.; average during trial, 4.1625 ft.	
Average steam pressure at engine	105.16 lbs.
Average pressure in force main	95 67 "
Average vacuum in suction main	2.38 "
Pressure equivalent to distance between the 2 gages	26.13 "
Net load on plungers per sq. in.	124.18 "
Mean effective pressure: h. p. cyl., 48.82 lbs.; l. p. cyl., 14.663 lbs	
Average piston speed per minute	133.3 ft.
Net work done in the 24-hour test	26,779,100,000 ft. lbs.
Duty per 1,000 lbs. feed water	117,325,000 ft. lbs.
Capacity in 24 hours, as calculated from plunger displacement	11,202,000 galls.
Average indicated HP. developed by steam cylinders	605.88 HP.
HP. calculated from work done	563.5 HP.
Efficiency of engine	93%
Dry coal actually burned per I.HP. per hour	1.74 lbs.
Pounds of water evaporated from feed at 153.26° Fahr. to steam at 110.05 lbs., per I. HP. per hour	15.70 "

Summing up the results of the test, the Board find the capacity of each engine in gallons of water pumped in 24 hours to be 12% above the requirements of the contract. This result was obtained working against a head 14% in excess of that stipulated in the contract and at piston speed 11% less than that allowed. The duty of the engine, of 117,325,000 ft. lbs. per 1,000 lbs. of feed-water, is 11.7% in excess of contract requirements. The boilers showed an evaporative capacity of 5,423 lbs. of water per 24 hours, or 11% in excess of contract requirements; and their efficiency was above that specified.

RESULTS OF WEIR MEASUREMENTS.

The amount of water pumped was measured both by plunger displacement and by the discharge over a weir. Unfortunately, the brass frame of the weir was only set the night before the test began. The Portland cement in which it was set froze during the night, and when the water began to flow over the weir the cement slowly disintegrated, and the reduction in the indicated flow over the weir due to this cause during a period of 17 hours amounted to about 1.2%. The results of the weir measurements near the beginning of the test showed a volume of water flowing over the weir (calling the pump displacement 100%) of 98% by the formula of HAMILTON SMITH, JR.; 97.3% by the formula of J. B. FRANCIS, and 97.1% by the formula of FTELEY and STEARNS.

A comparison was also made between the results obtained by measuring at 30 second intervals and at 15-minute intervals the height of the water in the weir chamber and at the weir crest. In the first trial the readings at 30-second intervals indicated an average discharge 0.03% less than that indicated by the readings at 15-minute intervals. In the second trial the readings at 30-second intervals showed an increase of 0.18% in the indicated discharge compared with the readings at 15-minute intervals.

The Comparative Merits of Various Systems of Car Lighting.

X.

OIL-BURNING LAMPS.

Owing to some delay in the preparation of matter and illustrations, we are obliged to postpone until next week the paper in this series on the use of oil lamps for car lighting.

AN OIL PIPE LINE, from the immense oil fields of Wyoming to the Missouri River, is projected by an English syndicate, which it is claimed is ready to invest $4,000,000 in the scheme. The best Wyoming oil lands belong to Pennsylvania owners, and the purpose of the syndicate is said to be to cheapen transportation to tide-water.

The Saint Mande Accident and the Westinghouse Brake.

The fatal accident of July 26 at the Saint Mandé station of the Vincennes Railway, near Paris, was ascribed by the engine driver of the colliding train to the failure of the Westinghouse brake. The train run into was made up of an engine and 24 cars, and was bound for Paris, and the colliding, supplementary train had in it 16 cars. To test the statement of the engineer, experiments with the brakes were conducted on Aug. 3-4, by the Chief Engineer of maintenance of way and traction of the Railway Company of the East, in the presence of a commission of State engineers. These experiments are fully reported in *Le Génie Civil* for Aug. 22, but without going into the full detail we abstract the following:

The tests had for their end the finding of the time necessary to pass the short train out of the station of Vincennes on to the line leading to Saint Mandé. (2) To find in what distance a train, regularly operated, could be stopped by the Westinghouse brake applied at a point where the signal light on the rear of the forward train could be seen. (3) To find in what distance the rear train could stop itself from the tail of the forward train by applying the Westinghouse brake, but leaving the steam on the engine. (4) To put the rear train in the condition which the engineer pretended it was at the time of the accident, that is with the valve of the Westinghouse brake closed between the fourth and fifth cars. (5) To start the rear train with ordinary speed and to stop it by the hand brakes alone and without the aid of the Westinghouse brake.

The experimental train was made up exactly as was the one causing the accident, with 14 cars, with seats on the roof, an engine, and a guard's van following the engine, and another ending the train. The total length of the train was 504½ ft. from end to end. The engine weighed 125,400 lbs., and the total empty train weighed 383,064 lbs., not including the engine.

As the result of the first experiment it was found that it took just six minutes for the train to pass from the Vincennes Station, and upon the Saint Mandé line, and occupy the place of the train struck, which had passed ahead some moments before the collision. In the second experiment the rear train left the Vincennes Station with a speed of 40 to 50 kilometres; the Westinghouse brake acted regularly upon the whole train, and the steam was shut off at the point where it was customary to do this. The point occupied by the rear of the train struck was indicated by a stake surmounted by a red lantern. In passing over the point from which the red light of the forward train could be seen, that is at 853 ft. from the rear of the forward train, the brake was applied, and the advancing train was stopped in 131.2 ft., or about 722 ft. from the tail of the forward train.

For the third experiment, the train returned to the Vincennes Station, and it left this under a full head of steam and this time the steam was not shut off. On arriving in sight of the lantern, the Westinghouse brake was applied and the train was stopped in 311.6 ft., or still 542 ft from the rear of the forward train. The fourth experiment was important, for an employee in the Saint Mandé Station and the engineer had stated that a valve in the Westinghouse brake, between the third and fourth cars, had been closed and consequently the brake did not act upon the whole train. The colliding train was then placed in this condition by the engineer, with the valve indicated shut. When the train arrived in sight of the red light the Westinghouse brake was applied to the engine and the first four cars. The train was stopped 410 ft. from the rear of the train in the Saint Mandé Station.

These experiments seemed to perfectly establish the responsibility for the accident, but the State engineers insisted upon the fifth test. They started afresh from the Vincennes station, and with something more than the normal speed. The Westinghouse brake was not used at all this time, reliance being placed solely on the hand brakes, which acted only on the wheels of the locomotive. At the same point as before the handbrake was put on, and the train was stopped 46 ft. beyond the stake and lantern. It was admitted by the engineers that a collision under these conditions would produce but an insignificant shock. In all these experiments the engine was never reversed to assist the brakes.

As a result of these experiments, rigorously conducted and conclusive, it was decided (1) That the Westinghouse brake did not fail to act. (2) That if it had been applied, even tardily, the catastrophe would have been surely averted.

A Fast Run on the Philadelphia & Reading R. R.

A fast run on the Philadelphia & Reading R. R., Aug. 27, was noted in our issue of Sept. 5, and we have since received further information from Mr. J. A. SWEIGARD, General Superintendent. The run was on the New York division, between the station at Ninth and Green Sts., Philadelphia, and Trenton Junction, and the fast time was made between Jenkintown and Trenton Junction, the grades ranging from 5.28 to 36.96 ft. per mile in favor of the train, and 7.02 to 33.79 ft. per mile against the train. The train was a special, consisting of two passenger cars, Nos. 366 and 658, weighing 42,900 and 57,200 lbs. respectively, and the private car "Reading," weighing 70,850 lbs. The engine weighed 98,000 lbs. and the tender, 68,300 lbs. loaded. Weight of train, 170,950. Total weight of engine and train, 337,250 lbs. The locomotive was an eight-wheel engine, No. 206, class D 33, with a Wootten firebox, burning hard coal; cylinders, 18½ × 22 ins.: four driving wheels, 68 ins. diameter. The fuel used was one ton of egg coal. The official record of the run is as follows, to which we have added the rate in miles per hour.

No. of mile.		Time at mile post.	Seconds per mile.	Miles per hour.
1	Noble	.45	45	80.0
2	to	1.27 3-5	42 3-5	84.5
3	Bethayers.	2.12 1-5	44 3-5	80 7
4	Bethayers	2.59 2-5	47 1-5	76.3
5	to	3.45 3-5	46 1-5	77.9
6	Somerton,	4.28 1-5	42 3-5	84.5
7	Somerton	5.10 3-5	42 2-5	84.9
8	to	5.52 3-5	42	85.7
9	Neshaminy,	6.32 3-5	40	90.0
10	Neshaminy	7.12 2-5	39 4-5	90.5
11	to	8.00 1-5	47 4-5	75.3
12	Langhorne.	8.42 1-5	42	85.7
	Total.....	8.42 1-5	522 1-5	

This train arrived at Ninth and Green Sts., Philadelphia, on the return trip, at 3.26 P. M., and was attached to train No. 524, leaving at 4 P. M. for New York, which point was reached on schedule time. As already noted this train has beaten the record for speed, the next highest on record being 86 miles per hour with a two-cylinder compound engine on the Northeastern Ry., England, and 84 miles per hour with an eight-wheel engine on the New York, West Shore & Buffalo R. R. Another fast run on the Philadelphia & Reading R. R. was noted in our issue of March 15, 1890.

THE 12-IN. RIFLED MORTAR, cast-iron and steel-hooped, was tested again at Sandy Hook last week. The target was a 4½-in. navy protective deck cast-steel plate, placed at an angle of 60° and 125 ft. from the mortar. The steel projectile weighed 628 lbs. and was made at Bethlehem, Pa. The charge of 51 lbs. of powder was proportioned for a range of 6,000 yds. with the regulation charge. The plate was so badly shattered by the shock that it was useless for another trial.

THE MANCHESTER CANAL, according to the Special Ship Canal Committee's report to the Manchester corporation, has cost to date $51,797,995. This amount has been expended. The corporation is discussing the question of loaning the canal $750,000 against second mortgage debentures. In addition to this the canal company has a banking over draft of $875,000.

PERSONALS.

Mr. L. C. CHATHAM has been appointed City Engineer of Columbus, O., vice Mr. R. R. MARBLE.

Mr. V. G. BOGUE, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Portland & Puget Sound R. R.

Mr. JAMES RITCHIE has been appointed Principal Assistant Engineer of the Cleveland, Cincinnati, Chicago & St. Louis R. R.

Mr. R. H. DILL has been appointed Superintendent of the main stem division of the Georgia Central R. R. vice Mr. W. W. STARR resigned.

Mr. J. L. FRAZIER, formerly Superintendent of the Chesapeake, Ohio & Southwestern, has been appointed Superintendent of the main line of the Southern Pacific Ry.

Mr. W. M. HUGHES has resigned his position as Engineer of Construction at the Columbian Exposition, and accepted a position with the Illinois Steel Co., Chicago, Ill.

Mr. C. F. KERCHNER has resigned as Superintendent of the Baltimore & Lehigh R. R., and accepted the position of General Sales Agent with the Monongah Coa & Coke Co., with headquarters at Monongah, W. Va.

Mr. FRANK S. DAVIES, for some years and unti recently employed on the Burlington & Missouri River R. R., has been appointed City Surveyor of Beatrice, Neb., vice Mr. O. V. P. STOUT, who has resigned to accept the position of instructor of civil engineering at th Nebraska State University, Lincoln, Neb.

NEW PUBLICATIONS.

—*The Measurement and Division of Water.* Bulletin No, 1?. By L. G. CARPENTER, M. S., Professor of Irrigation Engineering, State Agricultural College, Fort Collins, Colorado. Second edition. 8vo. 45 pp. Free to all interested in this subject.

This is a revised and somewhat enlarged edition of the exceedingly valuable pamphlet noted by us in our issue of March 14, 1891. It has for its subject the just distribution of water, one of the most difficult problems in irrigation, and one that is the least generally understood in practice. We will not repeat the review referred to; but to show how much the work of Prof. CARPENTER has been appreciated, we quote from his last letter to us as fellows: "Your notice materially hastened the exhaustion of the first edition of 3,000 copies, for requests were received from every state and almost every city in the United States, and many requests came from other countries."

—*House Heating. The Metal Worker's* essays on—By steam, hot water and hot air, with tabular comparisons. Arranged for publication, by A. O. Kittredge, editor of *The Metal Worker, Carpentry and Building*, etc., New York, 1891. David Williams, publisher. Large 8vo. 288 pp., diagrams, etc.

This is the result in book form of a series of prize competitions in house heating inaugurated by *The Metal Worker* in the fall of 1888 and reprinted from the columns of that paper. According to the conditions of the competition, scale drawings of house elevations, and plans were required showing the arrangement of apparatus, run of pipes, etc. There was also to be a full description of the work in each case, the amount of heating surface in the several rooms, with the reasons for each step and a detailed estimate of cost. The essays are arranged under the heads of combination systems, steam, hot water and hot air systems. Of the first, two essays were sent in. In steam heating four were presented; in hot water three and in hot air six essays.

These essays are here handsomely presented, and cover very fully the detail required in the above given stipulations, the result is an exceedingly useful work, giving examples and argument for all of the well-known systems. Each essay is printed with marginal heads, which add much to the true value of the work as a book of reference.

—*The Coal Trade.*—Coal production, prices, transportation, etc., at home and abroad, by FREDERICK E. SAWARD, editor of *The Coal Trade Journal*, 1891, 18th year of publication, 8vo., paper; 117 pp.

An exceedingly useful work for all interested in coal production and consumption. The pamphlet commences with a review for the year 1890, covering the world's production of about 500,000,000 tons for the year, and including product, ruling prices, character and destination. Following is a more detailed statement by States and countries, and covering the receipts of coal at the various great shipping points. In the coal production of the world the figures for 1889 show a to al of 468,576,321 tons, of which England and the United States mined three-fourths, or, in round numbers, 177,000,000 and 132,400,000 respectively and in the order given. Germany, France, Austro-Hungary and Belgium follow next in the order here given, but 153,000,000 tons will cover their united production for 1889. The pamphlet also treats, but to a limited extent, of natural gas as fuel, accidents in mines, smoke as waste, the utilization of culm, etc.

—*Test of Worthington Pumping Engines at Memphis, Tenn.* Final Reports of J. J. DE KINDER, A. J. CALDWELL and CHAS. B. BRUSH on the Test of the Pumping Engines and Boilers, furnished by HENRY R. WORTHINGTON for the Artesian Water Co., Memphis Tenn. Test made Jan. 10 to 14, 1891. Pamphlet 7½ by 10 ins.; pp. 18, with plates.

A full abstract of this interesting report is printed elsewhere in this issue.

—*How to Purchase an Electric Plant.*—H. Ward Leonard & Co., New York. Paper, 4 pp.

This is an explanation of the company's methods, as already described in our issues of Aug. 22 and Sept. 5.

SOCIETY PROCEEDINGS.

International Congress of Hygiene and Demography.

(*Concluded from page 212.*)

On the morning of Thursday, Aug. 13, the first paper in the engineering section was by Dr. Percy F. Frankland on "The Present State of Our Knowledge Concerning the Self-Purification of Rivers." He referred to the more important experiments which had been made in Great Britain on various rivers. These experiments all negatived the theory of self-purification as regards dissolved organic matter, although unmistakable improvement was traceable in the case of suspended matter. The author reviewed the work of several foreign investigators, who in some respects were out of harmony with each other. The author referred to his own experiments on the removal of microbes from water by agitation with solid particles, and pointed out how his results served to explain the diminution in the number of microbes in river water through sedimentation as observed by Prausnitz and Frank. The self-purification of rivers had frequently been supposed to justify the use of river water which has received sewage contamination for town supply, but Dr. Frankland contended that the evidence of purification was wholly inadequate to justify such a course. Unanimity only existed with regard to self-purification by sedimentation, which could never guarantee the absence of danger, while of the removal of dissolved organic matter to any larger extent there was no evidence at all. Of far more importance in securing the greater safety of water supplies for rivers and surface sources generally was their efficient filtration through sand.

A batch of papers on the disposal of refuse followed. Mr. Charles Jones A. M. Inst. C. E. read a paper on "Refuse and Refuse Destructors," in which early attempts to deal with the question were described. There had been difficulty in dealing with the gases given off by the material in the first stage of burning, and the dust which escaped from the shaft which was the cause of serious complaints and prevented the introduction of destructors. After investigations and careful consideration, the Jones fume cremator had been made, and these complaints were now things of the past. The gases are there subjected to a temperature of from 1,100° to 1,500° F., at little expense of fuel. The heat thus generated is used in a variety of ways, in connection with tubular boilers for pumping, for pneumatic ejectors, for driving of dynamos and working of various machinery for sanitary works, etc., thus effecting a considerable saving, and after repaying principal and interest leaving a balance. The speakers in the discussion were unanimous in approving of the destructor system of disposing of refuse.

The same subject, under the heading of "Refuse Burning," was discussed by Mr. W. George Laws, City Surveyor, Newcastle-on-Tyne. Refuse was broadly divisible into three classes, viz.: Sound material, crude material and unsound stuff. The last is the most difficult to dispose of. The proportion it bears to the whole varies with the mode of collection, though not much, and is about one-third of the whole. The hope of utilizing the third is fallacious. The theory of treating it by separation, mixing or otherwise was very plausible, but practice showed that the cost rarely fell below realizable value and generally far exceeded it. Refuse destructors were a clumsy expedient, not cheap, and unpopular. They were, however, fairly effective, and less costly than more scientific methods.

Dr. Miller Bruce followed with "How Best to Dispose of Refuse of Large Towns?" The question was now whether there should be one, or many small destructors. The best form of destructor would be a portable steam engine into which all the combustible material would be thrown, and these engines would perambulate the town, using the rubbish as fuel, thereby at the same time saving the expense of cartage and getting rid of the refuse. How this paper was accepted for reading before a scientific congress is a question which our correspondent is unable to decide.

Dr. Weyl, of Berlin, gave a short contribution on the cleansing of streets and removal of household refuse in German towns. The principle generally acted on was that the persons resident in a street and not the owner shall be responsible for its cleanliness. However, the municipal authorities undertake the cleansing of streets in much larger towns. In other towns only part of the roadway is cleansed at the expense of the authorities, the resident householders being responsible for the remainder. As a general rule tramway companies are obliged to contribute toward the cost of cleansing of streets. The removal of dust and household refuse has in many cases, as for instance in Berlin, been left to the householders, but the town authorities, however, retain a right of supervision. Some German towns make arrangements with contractors for the removal of all street refuse at a fixed rate. In other towns the cleansing of streets and the watering of the same is carried out by the town authorities. Under the system of municipal working, the utilization of refuse has up to the present been comparatively restricted. It is carted off to dust heaps and there left to so-called nature's influence—*Natur forschen*. From April, 1892, onward, the city of Berlin proposes to spread out its street refuse over some waste lands at a considerable distance from the city, so as to raise this low lying and unproductive land to a higher level and otherwise improve it. Under the contract system the contractors sell the household and street refuse as manure. The plan of separating the rubbish into useful and worthless parts does not obtain to any great extent in Germany. There is an establishment in Berlin for burning the refuse, but it is merely experimental.

Burning of Refuse.—This matter has been experimented with in Copenhagen, Denmark, and was treated by Mr. J. F. Meyer, Chief Director of Department of Sewers and Streets in that city. He stated that in England the house refuse contains much more unburnt coal than in most continental cities. It was, therefore, necessary to try if the burning, which is practicable in England, could also be applied on the Continent. A temporary furnace, arranged like a single cell of a Fryer's destructor, was used. The experiments may be divided into three classes, namely: (1) With the house refuse without any special preparation. (2) With the house refuse mixed with fuel and coke breeze. (3) With the riddled house refuse. The results were that the combustion of the unprepared house refuse was unsatisfactory as the mass would not burn continuously. With the mixture in proportion of one part fuel to four of refuse, the results were partly satisfactory, but the method could not be recommended. It was easily seen that to a great extent it was the large proportion of earth, sand and fine ashes in the house refuse which prevented its combustion. In using a riddle, through which about one-third to one-fifth volume was separated, a fully satisfactory result was obtained. The separated part consists of sand and fine ashes, and a small quantity of organic matter, which as was proved by some separate experiments, was easily made innocuous.

"Municipal Engineering."—Mr. H. Percy Boulnois, M. Inst. C. E., in reading a paper on the above subject, said that sanitary engineering, as a profession, was of quite recent date. Fifty years ago very little attention was paid to sanitary matters, and the importance of pure water, fresh air and the quick removal of organic waste were but little appreciated. Early in this century no English town possessed an officer whose duties were to deal with such subjects, and it was not until about 1847 that progress was made in this direction. An interesting diagram was given by the author of six chief branches of municipal engineering, the heads being engineering, law, surveying, miscellaneous, administration and architecture. Having described the ramifications of the diagram, he pointed out that municipal engineering required a large and varied experience, unremitting labor and attention, and a constant acquisition of knowledge. The public advantages derived from the work of the municipal engineer included well paved and lighted streets, well sewered and drained towns, pure water delivered to all parts of dwelling houses, public recreation grounds and parks and the amelioration of the condition of the people. It would be many years before the unostentatious character of his work would be appreciated, as local government was nearly always decried, and the necessity for taxation in order to carry out productive works would, for a long time, be unpopular.

Herr W. Kümmel, of Altona, read a paper on "The Epidemic of Typhus in Altona, 1891, and the Filtered Water." Reference was made to the serious epidemic in the town of Altona, while the much more populous and neighboring town of Hamburg was nearly totally free from it. Altona filters the water taken from the Elbe at Blankenese, while Hamburg has no filtration at all; but the water is pumped from the same river and delivered, without cleansing, to the consumers. Hamburg pumps the water from above the two towns of 750,000 inhabitants, while Altona gets its supply about seven miles below the towns; but the tide goes far above the spot where Hamburg water-works take the water. The Altona water is regularly examined to ascertain the number of bacteria present. Three to four weeks before the appearance of typhus the number of bacteria at once increased from 50 to 80 per cubic centimeter to 1,500. The doctors therefore suggested that the typhus had been spread by the filtered water, and that the number of microbes must have been largely increased by the filtration, though no bacteria of typhus were ever found in the examinations. At the same time the level of the underground water fell very much, and this might have been the cause of the epidemic just as well as the augmentation of bacteria in the filtered water. The fever cases increased very rapidly for a few weeks, disappearing in a very short time, and nearly at the same time the number of bacteria in the filtered water went back to the usual standard. Hardly anything was done to produce this result; some filters, not all the whole area of the filtering sand, were cleansed, and the old number of bacteria was again found.

Surgeon Major R. Pringle, M. D., read a paper on "The Water Supply of India". He stated that practically nothing had been done in the way of water supply for India up to the last 10 years. He described the wells and tanks of the country and gave his ideas as to the methods which ought to be adopted to improve the supply. He was followed by Señor P. Garcia Faria, of Barcelona, on "The Subsoil Drainage of Towns." The paper dealt with the relation between subsoil and drainage and sewerage, sewer ventilation, the separation of liquid sewage for the solid residue and the distribution of the latter on the land, sewer ventilation and the cleansing of sewers by an intermittent and by a continuous stream of water. These were the last papers read in this section and they were rushed through before a small audience, many members having departed to see sewage works or otherwise amuse themselves.

Section V., which dealt with Chemistry and Physics in Relation to Hygiene, was presided over by Sir Henry Roscoe, M. P., F. R. S., D. C. L., LL. D., who claimed that it was chemists and physicists who had laid the foundations of hygienic science. Fifty years ago "pump" water was looked upon as wholesome if it was cool and sparkling, and water from a source now recognized as dangerously impure was preferred to the pure article which came from a distance in the city mains. Now the sanitary authority closes all doubtful wells, and municipalities incur vast expense in bringing home to every one a pure supply. Still much remained to be done in rural districts. The question of air pollution was more difficult. We could bring pure water into our houses by pipes, and also take away the polluted water by sewers, but the question of ascertaining how far air is impure, was only now beginning to be understood. As regarded fogs, the ultimate panacea would probably consist in using gaseous fuel and the electric light. One source of air pollution was comparatively easy to grapple with, namely, the escape of deleterious gases from chemical works and other manufactories. The removal of many causes of such pollution had been satisfactorily accomplished in Great Britain under what are known as the Alkali Acts. Thanks to these, the serious complaints which once arose of nuisance due to the escape of acid and other noxious vapors are now no longer heard. Not only had the public been the gainer by the stoppage of escapes which formerly occurred, but the manufacturers themselves had benefited also, inasmuch as they had had their attention directed to improvements in their processes which had proved remunerative. Much, doubtless could be done in preventing the output of smoke from factories and other places in which large quantities of coal were burnt, but the smoky atmosphere of towns was caused chiefly by the thousands of domestic fires, and at once to alter these so as to prevent smoke, or to insist upon gaseous fuel being generally used instead of coal, was to expect the impossible.

Section VI. was that which was devoted to the subject of Architecture in Relation to Hygiene. The president was Sir Arthur W. Blomfield, M. A., A. R. A., F. R. I. B. A. Taking the usual definition of architecture as the "art and science of building," its relations, he said, to the science of hygiene become too varied and too complex to admit of clear and concise description. A connection between the two, however, undoubtedly existed, and it would not be hard to prove that, although never, perhaps, closely followed up or fully worked out in all its bearings, the idea of some actual relation between beautiful and artistic surroundings and health must have been present in the minds of many writers, both ancient and modern.

In some sections, as, for instance, in IV., relating to Infancy, Childhood and School Life, resolutions were passed, but in others no conclusions were come to. The result was that papers were read expressing quite contradictory views, and the brief discussions which took place did not allow of such an amount of opinion being given which would serve to draw inferences as to where the balance of the argument lay. This is rather to be regretted, as the value of the Congress is thereby minimized.

As the proceedings drew to a close there was a greater tendency to desert the lecture rooms in favor of sightseeing, entertainments and social gatherings, and on the last purely business day, the Friday, papers were very hurriedly passed through. The Saturday was entirely devoted to excursions, and on Monday, Aug. 17, a general winding-up meeting was held, at which not a tithe of the number present at the opening gathering, exactly a week previous, was present. Sir Douglas Galton occupied the chair, and stated that the number of members was larger than any they had ever had before. The papers read were of high value, and would produce a permanent influence on the branches of hygiene and demography to which they severally referred. It was announced that Buda-Pesth would be the meeting place of the next congress, which would be held in 1894. Dr. Körösi, of that city, offered a prize of 1,500 francs for the best work on the subject of demography and its progress in the chief countries of Europe and in the United States of America.

Boston Society of Civil Engineers.—At the meeting on Sept. 16, Mr. F. P. Stearns, Chief Engineer Massachusetts State Board of Health, will present a paper on "Selections of Sources of Water Supply."

New York Railroad Club.—The first regular meeting after the summer vacation will be held at the Club Rooms, Gilsey House, Sept. 17, at 2 P. M. Probably there will be no paper presented, but the Executive Committee hopes that members will come prepared to present topics for discussion at future meetings and to take some measures to indicate the subjects that they would like to have taken up during the winter season.

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AND

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COMING TECHNICAL MEETINGS.

American Society of Swedish Engineers.—Oct. 3. At 250 Union St., Brooklyn, and 347 North 9th St., Philadelphia.
Northwest Railroad Club.—Oct. 3. Rooms, Union Station, St. Paul.
Civil Engineers' Society of St. Paul.—Oct. 3. Secy., C. L. Annan.
Engineers' Club of Kansas City.—Oct. 5. Rooms, Baird Building. Secy., H. Goldmark.
Atlanta Society of Civil Engineers.—Oct. 13. Secy., Parker N. Black, Room 39, Capitol Block.
Denver Society of Civil Engineers.—Oct. 13. "Municipal Engineering." Secy., Geo. H. Angell.
Northwestern Society of Engineers.—Oct. 13. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.
Civil Engineers' Association of Kansas.—Oct. 14. Secy. J. C. Herring, Wichita, Kan.
New England Railroad Club.—Oct. 14. Rooms, United States Hotel, Boston.
Civil Engineers' Club of Cleveland.—Oct. 9. Secy., A. H. Porter, 50 Euclid Ave.
Northwestern Track and Bridge Association.—Oct. 9. Rooms, Union Station, St. Paul.
Western Railway Club.—Sept. 15. Rooms, Rookery Building, Chicago.
Engineers' Society of Western Pennsylvania.—Sept. 15. Secy., J. H. Harlow, Pittsburg, Pa.
American Society of Civil Engineers.—Sept. 16. Secy., Francis Collingwood, 127 East 23d St., New York.
Engineers' Club of St. Louis.—Sept. 16. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.
Boston Society of Civil Engineers.—Sept. 16. Secy., S. E. Tinkham, City Hall.
Engineers' Club of Cincinnati.—Sept. 17. Secy., J. F. Wilson.
New York Railroad Club.—Sept. 17. Rooms, Gilsey House.
Scandinavian Engineering Society of Chicago.—Sept. 17. Secy., T. G. Philfeldt, 113 Adams St.
Montana Society of Civil Engineers.—Sept. 19. Helena.
Engineers' Club of Minneapolis.—Oct. 1. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Association of Civil Engineers of Dallas.—Oct. 2. Secy., E. K. Smoot, 803 Commerce St.
Technical Society of the Pacific Coast.—Oct. 2. Secy., O. von Geldern, 819 Market St., San Francisco.
Western Society of Engineers.—Oct. 7. Secy., J. W. Weston, 230 La Salle St., Chicago.
American Street Railway Association.—Annual convention at Pittsburg, Pa., Oct. 21, 22, 23. Secy., Wm. J. Richardson, Brooklyn, N. Y.
Engineering Association of the Southwest.—Oct. 9. Secy., O. H. Landrett, Nashville, Tenn.

WE have received several letters criticising the distribution of weights in the article on "Steel Foundations," published in our issue of Aug. 8. These letters have been sent to the author of the paper for his comment, and as soon as we hear from him they will be published.

THE test of the high duty pumping plant at Memphis, Tenn., which is reported elsewhere in this issue, presents some interesting features. An innovation was made in drawing the original contract by specifying that the steam used should be measured by the water pumped into the boilers, with no deduction for the water entrained in the steam. The duty required was based on the foot pounds of work done per 1,000 lbs. of steam, "to be taken as regards saturation and entrainment of water as delivered to the steam cylinders by the boilers and fixtures furnished by the contractors," and "to be measured by the quantity of water delivered to the boilers during time of trial."

The Board of experts who conducted this test interpreted these two clauses to mean that all the water pumped into the boiler was to be charged to the engine. As the plant showed a duty and capacity far in excess of that specified in the contract, this interpretation of the clause will probably not be criticised by the parties to the contract. But in view of circumstances which might arise, in which the acceptance or rejection of a pumping engine might depend on the interpretation of a similar clause and in which the practice here followed might be cited as a precedent, it seems that some discussion of this point ought to be had.

The intention of the makers of the contract seems to have been to give the contractor a strong incentive to put in a plant which would furnish dry steam to the engine; and it was doubtless expected that he would make sure of this by the practice, now very common, of placing a separator next the engine. The 1,000 lbs. of steam on which the duty was based was to be steam "delivered to the cylinders by the boilers and fixtures furnished." While it was to be "*measured* by the quantity of water delivered to the boilers," it is not plain that this clause meant anything more than that the feed water record was to be taken as a basis, from which the entrained water and the condensation in the steam-pipe, which were collected in the separator, were to be deducted.

In a close case, too, the contractor might claim with some show of reason that the steam condensed in the jackets and reheater was not "steam delivered to the steam cylinders," and should not therefore be included in calculating the duty. This, however, is not in accord with usual practice in which the steam furnished to the jackets is charged against the engine, and it was not probably the intention of the makers of the contract.

IT must be said that there is considerable common sense in so drawing contracts for steam plants that no deduction shall be made for the steam used by the engine on account of the entrained water. The contractor is thus given an incentive to furnish good dry steam to the engine and will build boilers of ample size to do it.

The general introduction of steam separators, moreover, has greatly simplified this question, for there are enough varieties of efficient steam separators now in the market to make the use of wet steam in an engine, where economy is any object, quite inexcusable. With an efficient separator, whether the boiler furnishes wet steam or dry steam makes little difference. The condensed water is (or should be) returned to the boiler, so the loss in heat is unimportant even when the percentage of entrained water is large.

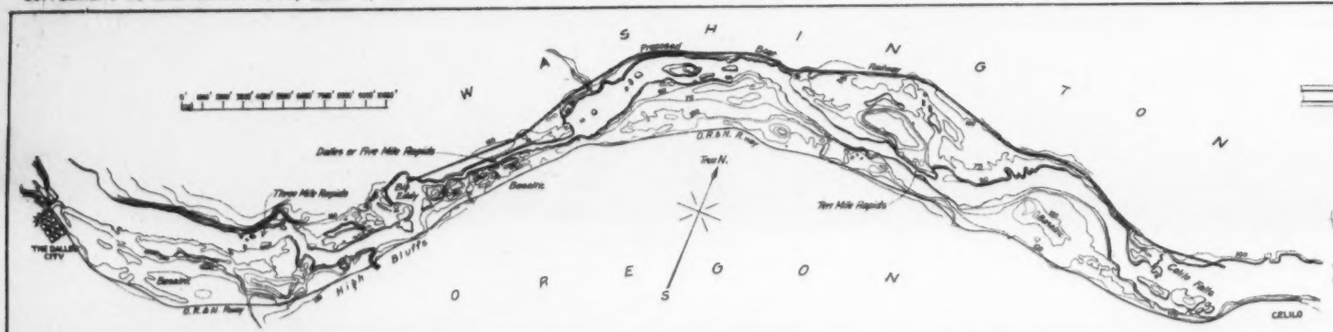
Again the measurement of the entrained water in the steam supply is an operation in which considerable percentages of error are liable to occur, especially if the instruments employed or the expert in charge of them be in any way defective.

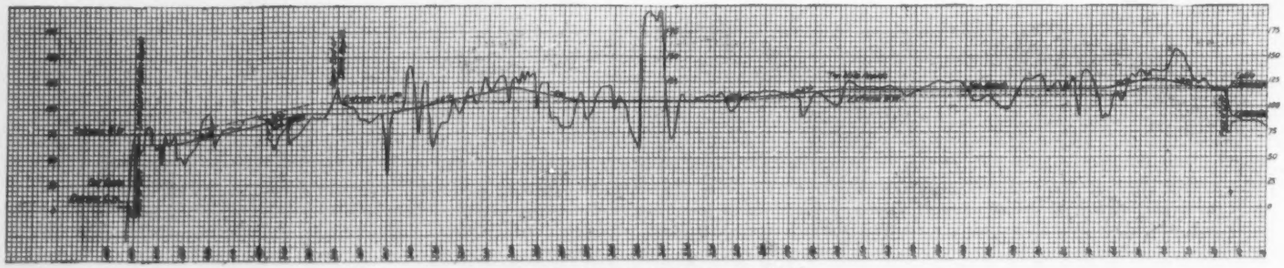
For all these reasons, the innovation made in this contract in taking the steam "as it is furnished to the cylinders" as the basis of duty measurement seems a good one, provided it were so interpreted as not to charge to the engine as steam the condensed water trapped in the separator. The effect of the interpretation of the contract made by the experts is evidently to increase the duty of the boiler, decrease the duty of the engine, and (since the hot condensed water from the separator and jackets was not returned to the boiler as is done in ordinary service) decrease the duty of the whole plant from the actual duty obtained.

ANOTHER matter which deserves a word of comment is that in looking over the report we fail to find any record of allowance for the slip or leakage of the pump in calculating the amount of water discharged and the amount of work done. Whether any allowance was made or not, we are unable to determine. Doubtless the slip in a pump so nearly new would be small; but it would be interesting to know how much it was, especially as it is stated that the water comes from a sandy formation, most of which is so fine as to pass a screen of 2,500 meshes per sq. in. Besides the effect of the correction for slip on capacity and duty records, the discussion of the accuracy of formulas for the flow over weirs, contained in this report, is incomplete without some statement as to the accuracy of the measurement by plunger displacement, which is taken as 100 per cent.

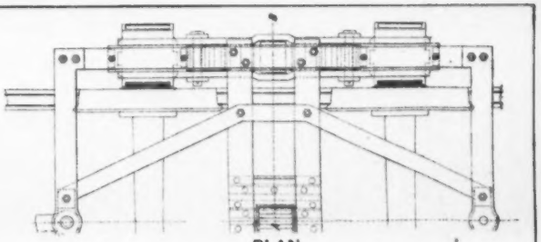
THE channel tunnel scheme was revived at the last meeting of the British Association by a plan presented by Sir EDWARD REED for a railway running in tubes of steel and cement concrete, laid on the bottom of the sea. The tubes would be 20 ft. in diameter, 70 ft. apart between centers, and built in 300 ft. lengths. These parallel tubes were to strongly braced together and the ends kept afloat, or above the surface, by some means not described, while the adjoining sections were being added. Hinge-joints were only referred to, and the tubes were to be supported on piers, having knife edged bottoms, which would cut into the soil. The estimated cost was given as somewhere between 60 and 75 millions of dollars, based on a price of $75 per ton for riveted steel tubes 2 ins. thick and a length for each of the two tubes of 120,000 ft.

The somewhat amusing part of this plan comes in to the American reader where Sir EDWARD provides a length of about 3,000 ft., emerging from the sea, which could be destroyed by gun-fire or by torpedoes. In other words, as Mr. GREATHEAD and other good authorities estimate the cost of a tunnel through the chalk at only 20 to 25 millions of dollars, on lines thoroughly explored and already proved by a trial tunnel of considerable length, the only argument for the excessive expenditure on the dubious plan proposed by Sir EDWARD is greater security against foreign invasion. With the expenditure of less than half the difference in estimated cost it does seem to us that if any defense were really necessary the chalk tunnel could be made a very uncomfortable and dangerous highway for a too venturesome foe. And in the discussion of comparative costs of proposed methods of crossing the Channel, Sir BENJAMIN BAKER said that the Schneider-Hersent bridge would cost $175,000,000, and that he thought Sir EDWARD REED'S tunnel would cost double the figures he had given. In the discussion which followed, however, the question of ventilating a 20-mile railway tunnel was brought up, and Prof. FITZGERALD figured that it would require an engine of 24,000 I. H. P. to ventilate such a tube, and that no dependence whatever could be placed on using the locomotive as a piston in this service. This was also the

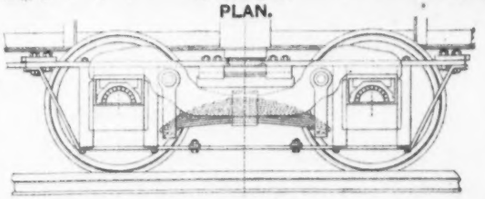




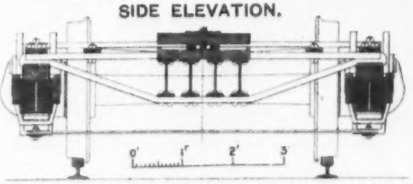
GENERAL PLAN AND PROFILE.



PLAN.

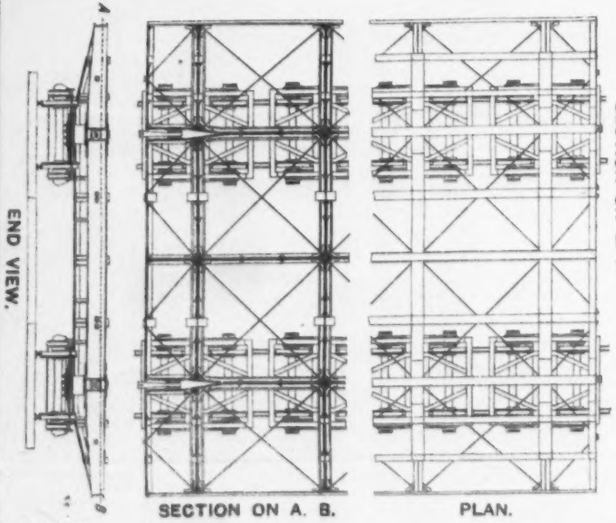


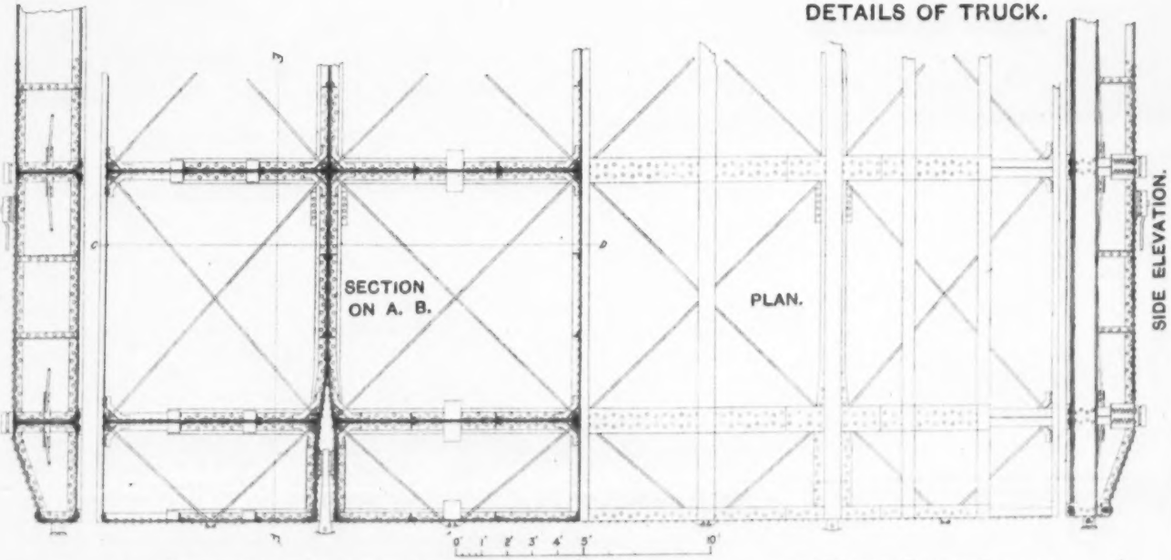
SIDE ELEVATION.

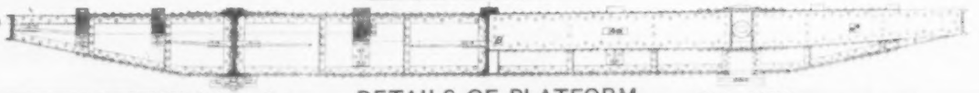


SECTION ON A. B.

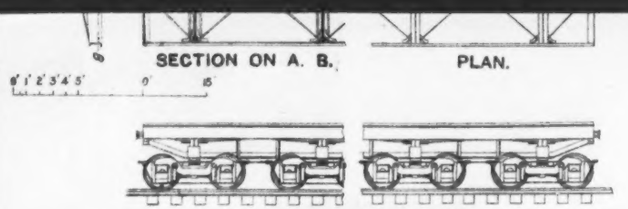
DETAILS OF TRUCK.



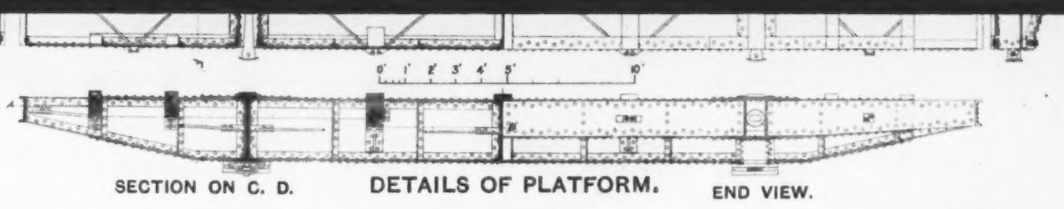


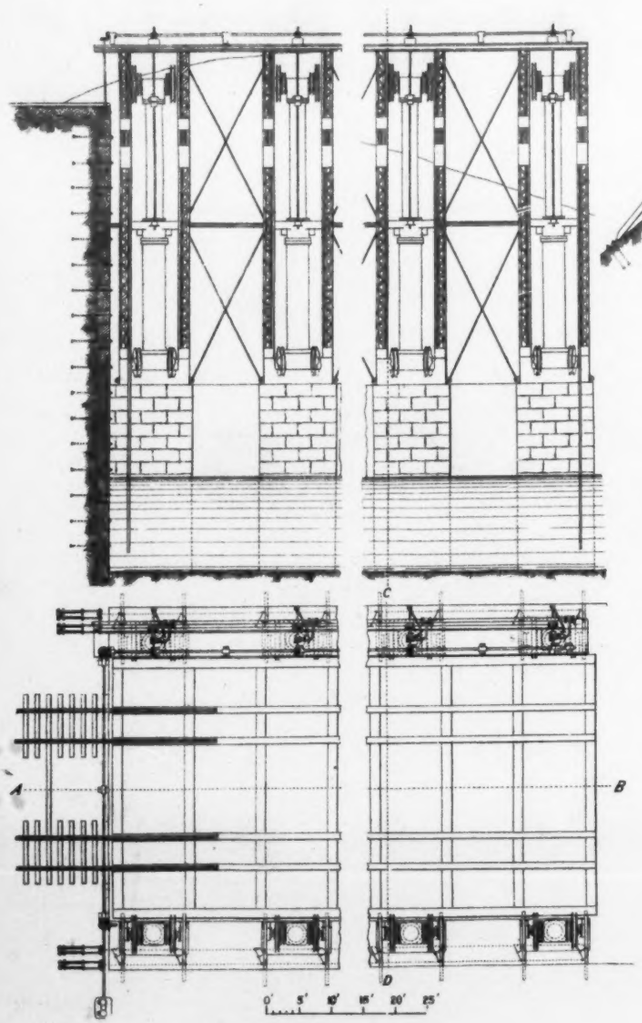


DETAILS OF PLATFORM

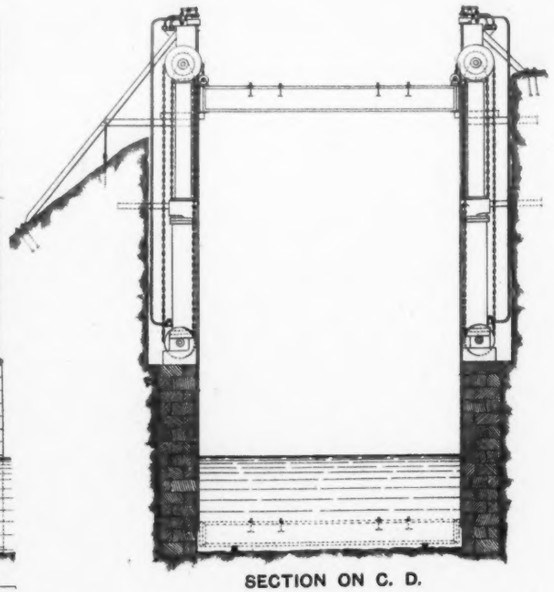


TRANSPORT CAR.

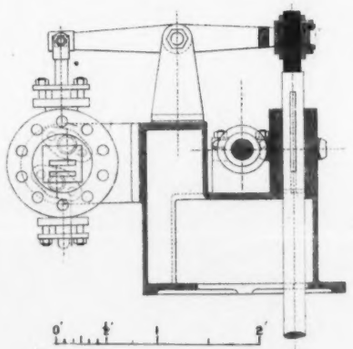




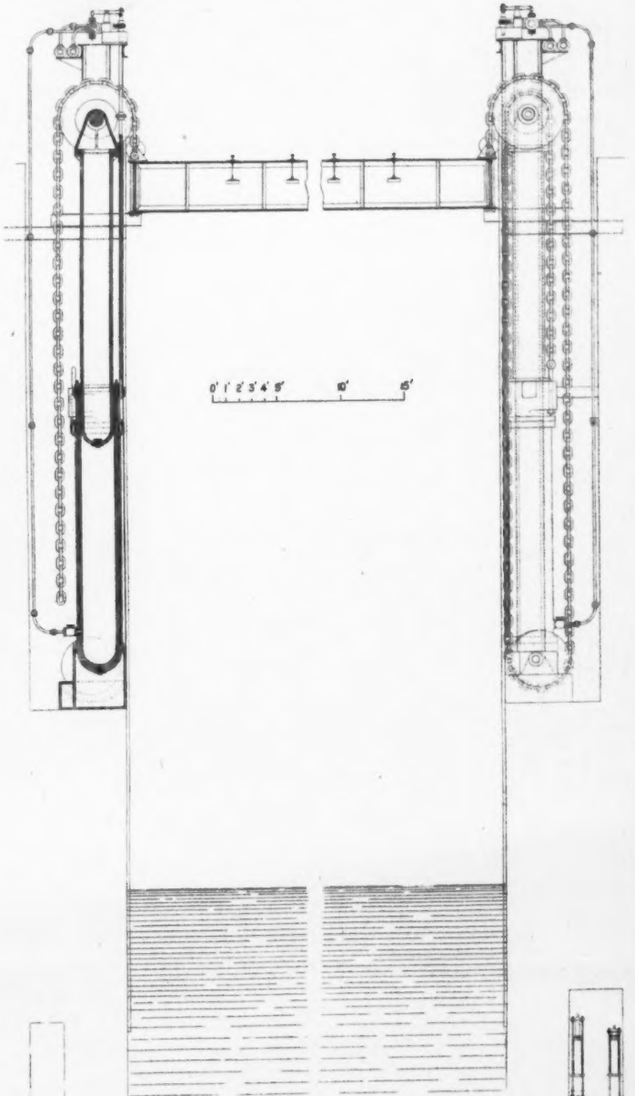
HYDRAULIC LIFTS.

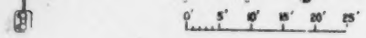


SECTION ON C. D.



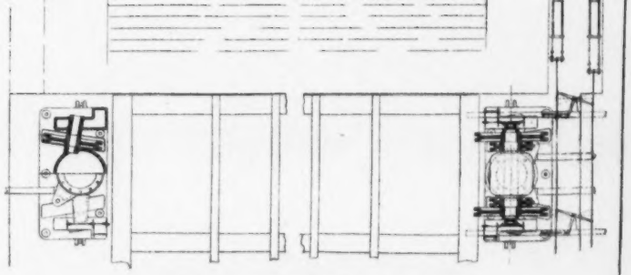
VALVE GEAR.





HYDRAULIC LIFTS.

VALVE GEAR.



DETAIL OF HYDRAULIC LIFT.

DESIGN FOR BOAT RAILWAY AROUND THE DALLES RAPIDS OF THE COLUMBIA RIVER.

COL. G. H. MENDELL, COL. WM. P. CRAIGHILL, MAJ. JAS. C. POST, BOARD OF ENGINEERS ON THE DALLES OBSTRUCTIONS.

LITH. CHAS. HART & SONS, 26 VESEY ST., N. Y.

opinion of Mr. GREATHEAD, who said that in the City & South London railway tunnel there were practically four ventilating shafts in the 3½ miles of its length. As the channel tunnel had not progressed that far, nothing was said about using motors of a non-smoke-emitting type. The ventilating of this submarine tunnel might be a problem worthy of later consideration; but in the meantime it is more than amusing to see how many abnormally costly and odd methods can be suggested for avoiding a simple tunnel through the chalk that needs financial rather than special engineering treatment to make it a success.

THE work of the government rainmakers in Texas and elsewhere has at least a scientific value, even if it fails in practice for causes and conditions not yet fully appreciated. There are strong arguments against the concussion theory, as pointed out by Col. MERRILL in a late letter to this journal, and by other writers, and there is also plausible evidence in its favor, as pointed out by Mr. POWERS in his "War and the Weather" and by Mr. HAZEN in the present issue. But whether useful rainfall can or can not be produced by the experiments now being conducted under the auspices of the U. S. Agricultural Department, these experiments are being carried out on a scientific basis, and our knowledge concerning the laws governing the condensation of moisture should be correspondingly increased. The fact that August is in the rainy season in Texas makes the result of experiments as reported from there decidedly doubtful, beyond the fact that violent concussion may have hastened the fall of moisture already gathering in the upper strata acted upon by the explosion of gas and powder. We do not think, however, that any one will be likely to regard the cost of these trials in the light of money wasted; but there is no doubt that the experiments will have to be many times repeated, and under all conditions of locality and season, before they can be accepted as of value.

IN our short note of last week on the report of the Committee of the American Society of Civil Engineers on the South Fork Dam, we inadvertently did an injustice to the Fishing Club in leaving our readers to infer that the original specifications of Mr. MORRIS for a spillway 150 ft. long were adhered to in construction, and that the Club shortened this to 70 ft. As explained in the letter of Mr. WILKINS this was not so. The original specifications were not adhered to for, as built in 1853, this spillway had an entrance width of 120 ft. and an outfall 176 ft. from the reservoir, only 69 to 70 ft. wide. This latter must be taken as the effective width. The investigations of the committee show that the rainfall preceding the Johnstown disaster was phenomenal for that region, and the flow into the reservoir was about 10,000 cu. ft. per second. But with the five lines of 24 in. sluice-pipes, originally in the dam, discharging to their full capacity with the waste-weir as constructed and free from obstructions performing its full duty, to discharge only 8,000 cu. ft. per second, the water surface at the weir would have been 10 95 ft. above the floor of the wasteway or one foot above the crest of the dam as originally constructed. For the discharge of the maximum of 10,000 cu. ft. per second the water surface would have been 12.63 ft., or nearly 2.63 ft. above the dam crest as originally built.

While the Fishing Club is responsible, in its repairs to the dam in 1862, for lowering the whole embankment about 2 ft. below the level of 1853, for removing the five sluice-pipes and for partially obstructing the spillway with gratings, etc., it is evident from the above that the disaster would have occurred even had the dam been in all essential particulars, at the time of the disaster, as it was when it left the contractors' hands nearly 40 years ago. These changes materially lowered the powers of resistance of the dam, but they only hastened and did not cause the disaster, says the committee of experts. We make this explanation in justice to the club, and to remove any wrong impression that our short news-note may have conveyed.

THE only lesson to be learned from the disaster at Johnstown is one already familiar to engineers, but neglected in practice in many existing dams not designed to waste water over the entire length of the crest. Mr. MORRIS recognized the value of an ample and seemingly superabundant width of spillway in his original plans, and why these were not adhered to can only be explained by the delay and changes in management incidental to state work at that period. Had his spillway been built and maintained it would have been sufficient, in the opinion of the committee, for the unprecedented flood of 1889, and thus have proved the wisdom of the engineer in providing for a very remote contingency. The security of the earthen dam itself was really not in question, for it was seemingly very well built originally; and though the repairs of 1862 were not of quite the same substantial character, the fault lay in the insufficiency of the spillway only, in permitting water to flow over the crest. Under these conditions the best earthen dam ever built would have been destroyed. The committee of engineers, in the concluding paragraph of its report, gives the only safe solution of this problem in construction when it says that "However remote the chance of an excessive flood may be, the only consistent policy, when human lives or even when large interests are at stake, is to provide wasting channels of sufficient proportion and to build the embankment of ample height."

What these proportions should be it is for the engineer to find out; by a careful study of the watershed, to which his dam is an outlet; and the discharging character of that watershed, whether steep and rocky and liable to suddenly pour down upon the dam a very large proportion of the rainfall, or whether it is of a spongy or absorbent nature, by reason of the soil and thick woods, and is likely to remain unchanged in character. Even with the most careful investigation and best laid plans, one spillway may be obstructed by drift-wood or waste of that kind; and this has to be provided for by booms, or by the more costly expedient of a double spillway. The careful investigation into the conditions surrounding the South Fork Dam disaster proves one thing very clearly, and that is that many dams still in existence are at any time liable to a similar fate and under a similiar combination of circumstances might bring about serious if not equally widespread destruction to life and property. It is to be hoped that the lesson will not be lost, though the too common tendency is, in matters of this kind, to await the warning that accompanies the disaster itself.

Accidents in the Railway Mail Service.

Are railway accidents in this country increasing or decreasing in proportion to the traffic? Have modern improvements in rolling stock, permanent way, and operating methods had an influence sufficient to offset the crowding of traffic, the increase of speeds, and the unsafe condition of old rolling stock, and old permanent way structures not calculated to sustain the heavy loads of present traffic? These are questions very difficult to answer, in the absence of accurate statistics. The general impressions of even the most experienced railway man are liable to be entirely erroneous.

We have recently found a little evidence on this point in the report of the Superintendent of the Railway Mail Service, consisting of statistics of casualties among postal clerks in the service since 1875. We give the table in full as follows:

CASUALTIES IN THE RAILWAY MAIL SERVICE FROM 1875 TO 1890.

Year ending June 30.	Total number of clerks.	Number of casualties.	Clerks killed.	Clerks seriously injured.	Clerks slightly injured.
1875.....	2,238	(*)	1	(*)	(*)
1876.....	2,115	(*)	1	(*)	(*)
1877.....	2,500	27	2	10	4
1878.....	2,608	36	2	15	3
1879.....	2,609	35	3	14	13
1880.....	2,916	26	..	14	15
1881.....	3,177	62	7	15	22
1882.....	3,570	83	3	16	20
1883.....	3,855	114	1	35	42
1884.....	3,963	154	7	28	60
1885.....	4,387	102	2	35	65
1886.....	4,573	211	..	56	60
1887.....	4,851	244	5	45	72
1888.....	5,094	248	4	63	43
1889.....	5,448	193	10	95	40
1890.....	5,836	261	4	41	53

* Not reported.

The variations from year to year, however, make it difficult to draw any conclusions from this table; and to eliminate them to some extent we have averaged the figures for two-year periods (excluding 1875 and 1876, for which the returns were incomplete), and finding also the number of clerks employed, per clerk killed and per casualty. The result is as follows:

Period.	Average annual number of: Clerks employed.	Casualties.	Clerks employed per casualty.	Clerks killed.	Clerks employed per clerk killed	Clerks seriously injured.	Clerks slightly injured.
1877-78.....	2,554	31.5	81	2	1,277	12.5	3½
1879-80.....	2,777	30.5	91	1.5	1,851	14	14
1881-82.....	3,373	72.5	46.5	5	675	15.5	21
1883-84.....	3,909	134	29.1	4	977	31.5	51
1885-86.....	4,480	156.5	28.6	1	4,480	45.5	62.5
1887-88.....	4,972	246	20.2	4.5	1,105	54	58.5
1889-90.....	5,642	227	24.9	7	806	68	46.5

While the above figures seem to show an increase in the rate of accidents during the period covered, the very small number of casualties reported in the first four years in the table makes it extremely probable that the real cause of the apparent increase is that the accidents were not fully reported in the first years covered by the report. As the period included in the table is only 14 years, it is not likely that any great change in the rate of casualties has taken place. The most that it would be safe to conclude on the basis of these figures is that the accident rate is not decreasing to any marked extent.

One thing on which this little table does throw a little new light is the present rate of accidents to passenger trains. Averaging columns 4 and 6 in the last table we find that during the past 14 years the average number of casualties per annum has been one for each 46 clerks employed, and the number of clerks killed in each year has been one for each 1,596 clerks employed.

The average number of miles travelled by each clerk in the service was 45,802 miles in 1890. Assuming that the average annual mileage for 14 years has been 45,000 miles, we find that the average rate of casualties has been one for each 2,070,000 miles traveled, and that one clerk has suffered death for every 71,820,000 miles traveled.

The information of the most practical value, however, is that obtained from studying the classified causes of the accidents reported in 1890. The most frequent cause of accidents was, of course, running off the track. Out of the total of 261 casualties reported, 91 were derailments, 67 were collisions, and the causes of the remaining 103 were as follows:

Misplaced or defective switches	29
Obstructions on the track	22
Defects of rolling stock	16
Bridges or trestles burned or defective	6
Washouts	3
Casualties other than train accidents	27

It is a good illustration of the very small fatality which results from derailments, that in all the 91 cases reported there was but one case where a postal clerk was killed, and he was off duty and riding in a passenger car. Collisions, although less in number were more fatal, three of the deaths being charged to this cause. This only confirms the fact, of which every careful student of accident records is aware, that collisions are at present the chief cause of fatal train accidents.

Another point on which this report gives some interesting data is the number of accidents in which fire occurred in the postal cars. As especial care is taken in reporting each accident to detail the amount of damage suffered by the postal cars and by the mails, we may expect the statistics on this point to be fairly accurate.

We find that in no less than 18 train wrecks reported the postal car caught fire, and in a large proportion of the cases was partially or wholly destroyed. The cause of the fire seems generally to have been the car stove, though the lamps were thought to have been the cause in a few instances. Besides the above fires, there were 9 cases in which a car was set on fire by other causes than train accidents. Two of these were due to the explosion of frozen pipes in Baker heaters, which scattered burning coals through the cars. The lamps seems to have been to blame for the other fires so far as the causes were known. In looking over the record it must be said that oil lamps show up pretty badly. There were no fewer than 35 accidents reported—beside those in which fire occurred—in which the mail matter was more or less saturated with oil from the lamps. This being the case it is hardly remarkable that the proportion of train wrecks in which fire occurred was so large.

We need hardly say that the obvious moral to be drawn from the above records is the need of a fireless system of heating for postal cars, since they contain a great amount of inflammable matter, which, the statistics show, is apt to be more or less saturated with oil in every serious wreck. The need of a safer system of lighting than oil lamps is also evident; but that need is very much diminished if there is no stove or other independent heater in the car, since the flame of the lamp is generally extinguished by any shock severe enough to scatter the oil.

A COUNTER-BALANCE RAILWAY, to assist an electric motor up and down a steep hill, has been put into operation in Seattle, Wash. It is the invention of Mr. J. P. F. KUHLMAN, the engineer of the railway. The device was called out by the fact that one street, for about 1,000 ft. in length, is so steep as to present difficulties in handling electric power upon it, the grades being 11, 14 and 16%. A cable line would have been too costly for that short length of road and the balance system was devised. As described in the Seattle *Post-Intelligencer*, two counter weights, aggregating 6 tons, ran on a track in a conduit 3 ft. wide and 15 ins. below the street surface. At the bottom these weights abut against an air cushion made of two 8-in. wrought iron pipes, 8 ft. long, enclosing 7 in. pistons of about the same length. At the other end of a steel cable attached to the counter weights is a small "dummy" running in a conduit 4 ins. wide by 8 ins. deep placed above the larger conduit. This dummy has a bar hinged to it and projecting 8 ins. above the ground, to which the drawbar of the car is coupled. In operation the loaded car descending the grade draws up the counter weight, which just about equals the weight of the empty car; the electric power and brakes are operated as on the level. In ascending the counter weight comes down and pulls up the car, with the assistance of the electric motor to handle the load. When the car is uncoupled at the foot of the grade an automatic catch holds the dummy in position for the next ascending car. A safety catch is employed with the weights in case of breakage of the rope, and the coupling is to be done automatically.

CORRESPONDENCE.

Artificial Rain.

WASHINGTON, D. C., Sept. 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The whole country has been stirred up on this question in the past month, and as I have noticed several contributions in your journal on this subject I have thought that I might add a mite. It would seem that all such experiments must shed some light upon the formation of rain, and hence they are of importance since we really know very little of the true cause of rain. The ordinary theory, that rain is caused by the condensation of moisture in an ascending current of moist warm air, is strongly negatived in this country by the fact that rain does not fall from the ascending current but 400 or 500 miles to the eastward.

The question arises, can science lend any support to the opinion that rain may be caused by concussions in the atmosphere? The present writer tried some experiments in 1889 on the possibility of producing condensation of moisture in dust free air. It will be remembered that Mr. John Aitkin had advanced the view that no condensation could occur unless there were dust particles as nuclei for it. These experiments, though made on a small scale, showed that condensation could occur in dust free air, and this was dependent, either upon the shock or sudden expansion forcing the particles of moisture together, or upon a very rapid cooling. (See *Science*, June 21, 1889.)

In corresponding with Mr. Aitkin I received the following from him in a letter dated Sept. 26, 1889: "I have pointed out in one of my papers that it is possible to produce condensation in dust free air. It is done by drawing out the air pump very rapidly and accompanying the process with a shock. Condensation then takes place for the same reason that water cooled below 32° immediately solidifies when treated in the same way." These experiments show conclusively that a sudden concussion of the atmosphere will cause the molecules or moisture particles to coalesce, as it were, and under proper conditions no doubt these drops would reach the earth. It is very evident, however, that this effect would be immediate upon the explosion and any rain which fell an hour after the explosion, or more than a mile away, could not be due to that.

It is interesting to note that this is the rainy season in Texas, and rain has fallen on sixteen days between Aug. 9, when the first explosions were made, and Aug. 30. It is very much to be hoped that careful measurements and observations have been made to determine the size of drops produced, the area over which the shock had any effect, etc. H. A. HAZEN.

The Spillway of the South Fork Dam.

PITTSBURG, Pa., Sept. 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your editorial of the 5th inst., commenting on the report of the committee of the American Society of Civil Engineers, you have, probably unintentionally, done the South Fork Hunting and Fishing Club an injustice. You say, "The original specification of Mr. W. E. Morris, the engineer, provided for a spillway 150 ft. long and 10 ft. deep below the crest of the dam. This spillway was reduced to 70 ft. by 8 ft. by the Hunting and Fishing Club."

The inference any uninformed reader would draw from the above sentence, is that the spillway *was constructed* 150 wide and by the club narrowed to 70 ft. This is not the fact. On page 455 of the committee's report you will find they say, "The waste weir was, however, not constructed according to Mr. Morris's specifications, instead of having an aggregate width of 150 ft. its effective width was less than 70 ft." A careful reading of the report will show that the waste weir was constructed under the directions of the Canal Commissioners and not by the Fishing Club, and that instead of being built 150 ft. wide and narrowed by the club to 70 ft., it never was built over 70 ft. wide. It follows, therefore, that instead of the club being culpable for the narrow waste way, the Canal Commissioners or their engineer were to blame for allowing the contractors to construct the waste way only 70 ft wide when the contract and specifications called for a width of 150 ft.

On page 456 of the report the committee, speaking of the changes which the club did make, and which you refer to in your editorial, viz., taking out the five sluices, lowering the embankment 2 ft., and obstructing the waste way by gratings, etc., say, "These changes materially diminished the security of the dam—but in our opinion they cannot be deemed to be the cause of the late disaster—it occurred a little earlier in the day on account of these changes, but we think the result would have been equally disastrous and possibly more so, as the volume of water impounded was less, and the greater width of the top of the embankment after the change and its consolidation by its use as a road for several years must have increased its resistance to the formation of the breast and required more time."

Your editorial would lead the average reader, who had not read the committee's report, to believe that it was adverse to the club, while the above extracts from the report show that such is not the case. Trusting that your sense of justice will prompt you to give this a place in your columns, I remain, Yours respectfully,

WM. GLYDE WILKINS.

[We comment further on this in another column. ED. ENG. NEWS.

Railway Surveys and Resurveys.*

Value of Preliminary Surveys.—One of the most common conceptions on regard to railways is the supposed great accuracy and completeness of their surveys, and of the records and maps relating to their lines of tracks, buildings, structures and ownership. This opinion arises in part from the amount and variety of surveying and plotting required in locating and constructing them. In the popular sense a railroad is a creation of the surveyor's art. He shares in nearly all the honors of the completed and successful enterprises, and somewhat of the misfortune and odium attaching to unrealized expectation. His organized bands that traverse field and forest, valley and plain, are always conspicuous figures in the public eye; their coming is a public event, it represents something of new possibilities, of hope, and aspiration.

But though surveys must precede railways, they are not a sure guarantee of their immediate construction. It is not uncommon that several companies are successively formed, with short or long periods of relapse between, to carry through a particular project, and one after another are forced to abandon the undertaking as beyond their reach. Because each of such several successive organizations may send out surveyors, the idea gradually prevails that there must be therefore exact and definite knowledge of the route, for it is asked: Has not the line been run over and over again? But it will generally be found, however, that when the work of building is finally decided upon, that many of the older surveys are of little use, and much yet remains to be done. Much of this is due to a change of conditions, and to new requirements. Other railways may have entered the original territory; other combinations may be necessary at the termini; and through the changes in the relative importance of towns and the advisability of reaching one town compared with another, the opening of mines, the development of industries there is pretty sure to be something that is turning up every year that makes it advisable to change the line in many places, and one change, though seemingly slight, may lead to many others.

Then, too, former lines, even of careful locations, are not easily exactly retraced after a few years. Stakes disappear, and even if an occasional one was found there would be such lack of precise measurement in the original survey, or in the attempt to lay it down anew by retracing it directly, the lines would almost certainly begin to separate after a few miles, unless there were careful checks on such lines by reference to property lines, roads, buildings and topography.

The lack of sufficient references and connections to other lines will generally be found, in such an event, to be the weak point of such surveys. The locating engineer saw much, and made use of much that he did not preserve any record of. He was selecting, marking and staking a line for use in the immediate future, not for another generation, and thus with the partial loss of such lines and the necessity of precisely restoring them not absolute, a resumption of the project is pretty sure to bring about many changes.

How fully and minutely a location should be connected with section lines, etc., is not within the present purpose to discuss. Many details of this sort are irrelevant to the purpose of locating, and belong and ought to be postponed until construction is definitely resolved upon. But what may reasonably be insisted upon is, that no line is worth running at all, unless it may be of some future use in case of revival of the project after abandonment. Not that it may be absolutely retraced, point by point, but rather that a good location may serve at least as a good preliminary for a new location. How well it may do this is a question of time, circumstance and occasion. The common mistake is, because the records and maps cannot be made voluminous and detailed, that no record whatever is made.

* By Hosea Paul, Chief Engineer, Toledo & Western Railway Co.

In this connection, it might be remarked that something simple, as for instance a line drawn across a township map, such as can be made in an hour, might be more available and valuable than something more elaborate.

Thousands of miles of lines are run every year, the results of which are unavailable beyond the immediate purpose, mainly from two reasons: First, a failure to note the general locality at frequent intervals, and especially with regard to section lines, etc. There must be care to set down things, even if somewhat by guess, rather than waiting for an opportunity to get something more definite and precise. The second reason for the unavailable nature of such surveys is the easy going way of referring elevations to some arbitrary datum. Whatever may have been the case years ago, the time is near at hand when one datum plane should be used for all elevations, and such datum is, of course, that of the Atlantic Ocean, as the same has been determined upon by various public surveys, and which have already been carried to many points. The knowledge where such elevations can now be obtained, and to keep up with the times somewhat as to the new sources of information which are being so rapidly multiplied, should be a part of the educational equipment of every engineer, and he should not permit himself to use anything else when such standard elevations are within his reach.

Right here, by way of remark, I might say every city should use sea levels, and I have frequently urged city engineers to change their arbitrary datum to one commensurate with others. The objection raised has been, aside from the trouble of change, that it would involve the use of too many figures. To this I reply that in Ohio an elevation of 953 feet, and in Colorado of 11,930 feet, the hundreds in one case and the thousands in the other might be omitted in field books, etc., being superfluous to insert but important to remember, like the indices in a table of logarithms.

Even after the various preliminary and location lines have been run and the work of construction actually undertaken the line is not yet unalterably fixed. The unexpected happens. Rock crops out in some unexpected place, quicksand is found in another, an obstinate land owner demands exorbitant prices, or there may be a quarrel with another company over a crossing—something or other will certainly occur to make changes in the line desirable or imperative, so that the location is never fully settled until the track is laid. These latter and "last minute" changes are often made without much system or record.

When at the end of construction a line of railway is turned over to the operating department it will generally be found that the surveys, records and maps are much less complete than is imagined. These deficiencies are mostly—

(1) Lack of definite information as to absolute length of line and distances between stations, etc.

(2) Lack of regular profiles, by reason of several assumed elevations not connected with each other, and because the lines or grades were changed during construction.

(3) Lack of systematic records and maps relating to the side tracks, buildings, structures and to the lines and titles of the lands claimed by the company.

As to the length of line, the previous surveys will be usually more or less unavailable for two reasons, one being the inherent inaccuracy of the work, due to haste, from incorrect chaining or uneven ground or by reason of the obstructions of trees, brush, logs, etc., and from the slip or change of position in the driving of stakes. The other reason, and usually the more controlling one is that there are breaks in stationing due to the exigencies of location, and to the changes and revisions which have increased or diminished the length of the line. These breaks in continuous measuring make the reckoning difficult and tedious, with constant risk of error.

The profiles are often still less available for any extended comparisons or general use, and are useful mainly for particular localities.

The records, graphic and written, relating to side tracks, buildings, structures, and property lines are mainly such as must be made up after construction. The first deficiency to be supplied is ordinarily that relating to the length of the track. A steel tape is procured and a couple of men detailed to measure the track, to set mile posts, and to note the distances between stations, and in a rude way, subject to future "fudging," obtain township lines, etc. Beyond this little is attempted and no marks are left. At some future time numbers may be painted on the telegraph posts, so as to serve to describe locations, and in any general repairs requiring surveys, the marking is special to the occasion.

For maps of the line in the country the location maps form the ground work, but in towns and villages where the details multiply they are of little service. Special surveys are a necessity here. Many of these maps are made in a desultory way for special and particular purposes, as the location of a wreck, or accident, the lines of a particular piece of land that may be in dispute, or which may be sought to be acquired. For such purposes the surveys are made by men specially sent out from the general office. They must accommodate themselves to time tables, and usually depend on unskilled assistants hastily picked up. These often incomplete and sometimes inaccurate surveys are returned to the office, and a map compiled therefrom, usually with liberal additions obtained from location maps, deeds, copies of town plots, etc.

After a time, such surveys and maps accumulate. They are rarely complete or uniform as to character, style or accuracy. One never knows what he may find on them, and rarely when, how or by whom it was obtained, or how much may be depended upon. They are usually made for a particular purpose and occasion; for a new one, they might be misleading, and in such case the ground must be visited again and thus, between new surveys and dependence on the memory of trusted employees who are supposed to remember everything but who sometimes fail to do so, there is continual uncertainty. Such a lack of system is unworthy the affairs and interests of a great corporation. That such a hand to mouth policy is no more economical than it is unsatisfactory scarcely needs illustration or argument. It only remains to point out a better way. This is by a thorough resurvey of the whole road, as soon after completion as may be.

(To be continued.)

The U. S. Naval Annual for 1890.

General information, Series No. X., entitled a "Year's Naval Progress," the annual issued by the Office of Naval Intelligence, has, after a delay of two months, finally made its long looked for appearance. The delay was caused in the Government Printing Office, which, under pressure of work, and at the time when this publication went to press, unadvisedly allowed about 300 of its employees to take their annual 30 days' leave, and in consequence this important publication was obliged to await its turn.

The first chapter is devoted to the classification of ships by nations; under the head of each nation are given the descriptions of individual ships of the types which they represent, with all the particulars relating to their cost, date of commencement, launching, steam and speed trials, and their results, and all the latest improvements in design, construction, distribution of armor and arrangements for making ships unsinkable are noted. The ships dealt with are those which are still in course of construction, those launched and preparing for their steam and speed trials, those now which have been commissioned during the year 1890 1891, and those to be laid down during the current fiscal year as provided for by the various naval budgets of 1891-1892. The vessels stricken from the Navy Lists are also noted, with the causes therefor. This chapter, as all the others, is arranged with the characteristic system of this publication, so that at a glance, without reference to the carefully arranged index, information relating to any particular navy, or to a particular ship of a navy, may readily be found. It is to be regretted that a complete history of each ship could not be given in this number, except by reference to previous publications; this, however, would involve an increase in the size of the volume to such an extent as to impair its handiness.

Chapter II. is of especial interest to naval and marine engineers, as it notes all the progress made in marine engines, boilers, and all the appurtenances of them; it also contains copious notes on the engines and boilers fitted to the new ships of the United States navy, as well as to the ships of foreign navies, and, in addition, notes on engine and boiler trials and experiments, forced draft and liquid fuel.

Chapter III. Notes on ordnance—always a favorite subject with executive naval officers—is perhaps the most elaborate, searching and exhaustive paper, since it deals with every conceivable device or invention which may be classed under ordnance, namely: high power, large calibre guns, rapid firing large and small calibre guns, machine guns and magazine small arms, projectiles (armor piercing), high angle firing guns, variously known as mortars and howitzers, gun mounts of all kinds and their appurtenances, the working of turrets and turret guns, smokeless powders, torpedos, and a description of the new English automobile torpedo known as the *Victoria*, with notes on torpedo nets and submarine mines.

Chapter VI was prepared by the same writer, and is entitled "the Armor Question," in 1891: it is a thorough review of all the armor experiments carried on during the year at home and abroad, from which valuable conclusions are drawn as to resistance to penetration of the various types of armor known as compound, all steel and nickel steel. The subject is treated under the following heads: (1) The development of compound armor plates as shown by details of the most noted trials of late years: (2) the trials of English steel armor plates in 1888; (3) the developments of Schneider steel armor plates as shown by details of the most noted trials of late years, (4) the trials of Cammell compound armor plate representing the armor of the Argentine coast defense vessel *Independencia;* (5) a comparison of English compound Vicker's steel, Schneider's steel and Schneider's nickel steel armor plates from the results obtained in the recent competitive tests at Ochta and Annapolis; (6) the first trial of nickel steel armor plate; (7) the armor best adapted to naval use.

Chapter IV., on "Electricity on Shipboard," is a valuable study, because of the lucid manner in which the writer presents the subject. It is intended to enable naval officers who are not experts in electrical matters to understand the practical manipulation of the numerous electrical machines and appliances which have become such important fittings on board of war ships.

Chapter V. on "Naval Manœuvres" is a compilation from official reports and of press dispatches. The writer reviews all the foreign naval manœuvres of 1890, giving the programme of each, the execution of the programme, the deviation, if any, from it, and the lessons to be learned from them individually and collectively.

The same writer in Chapter VII. very ably discusses the "Coast Defense Systems" of Europe, bringing out prominently the point recently made by Sir Drummond Jervois in his paper on "The Supremacy of the Navy for Imperial Defenses," namely, that most foreign powers recognize the "Coast Defenses" to be purely naval. In commenting the writer says: "The defense of a coast, and especially of a port, resolves itself into two parts, the active and the passive. The active includes gunboats, torpedo boats and harbor defense ships; the passive embraces submarine mines, rapid firing guns to protect mine fields, and batteries of heavy guns. The effective range of artillery is from 10 to 12 miles. A ship only two miles distant when in motion is a very difficult object to hit, while towns, manufacturing establishments, etc., can be bombarded at any practicable range. These facts, together with the development of rapid firing guns, the charging of shells with high explosives, the dynamite cruiser, torpedo and submarine boats and electric searchlights, have altered entirely the question of coast defense.

"If a navy is made thoroughly competent for its work, no other defense for a coast will be called into play; *and if it is incompetent, no other defense can prevent disaster to the coast.* It may, perhaps, be regarded still as a truism that real defense against heavy attack on most coasts is the old one of a reserve fleet in home waters. Thorough competency, though, to perform its work of attack and complete defense would involve, in any country, the construction of a very large fleet; and the result is that coast and harbor defense, like every other factor in war, *is a matter* of compromise.

. . . . . .

"In general, foreign powers recognize that the unity of control is a necessity in a properly organized coast defense system, and no half-way measures are regarded as admissible,

. . . . . .

"The coast defense systems of such powers are thus purely naval in organization, administration and control, or are rapidly becoming so."

Chapter X., on the "Systems of Promotion in the Several European Navies," is one which it would be advisable for all naval officers to study with care, and especially does this advice apply to those naval officers who make a practice of flooding the columns of the press with *their* schemes for promotion in the U. S. Navy.

Chapters IX. and XI. present new features. Chapter X.—The Torpedo Vessel—A history of its development, is especially interesting, not only because it treats of a comparatively new type of war vessel, but because of the pleasant and easy style of the writer.

In reference to Chapter XI. it may be said that it was a happy idea which led to its introduction, as it fills a long felt want, namely: A list of standard books on professional subjects. Each and every one of the papers which admit of illustration are amply illustrated, and it is to be observed that they are exceptionally well and carefully executed.

In conclusion, we may say that the officers of the navy ought to be gratified to have at their command such a valuable work, and that it reflects great credit on the office of naval intelligence and the chief intelligence officer.

Graphical Solution of Wiring Problems.

In our issue of July 11 we republished from the *Electrical World* a chart designed by Mr. THOS. J. FAY for determining by inspection the size of wire required to carry a given electrical current in an insulated copper wire, raising its temperature a certain amount.

By permission of Mr. FAY we publish herewith a second diagram, designed for use in determining the size of wire necessary to carry a certain current with a given percentage of loss. In the *Electrical World* of Aug. 1 the author described this diagram as follows:

The diagram which I now present is one for determining the length of a round copper conductor which is necessary in order to waste a given number of volts, or percentage of energy, at a given load in ampères. The first diagram is intended for use in proportioning conductors for cross-section, while the present one can be employed in proportioning for lengths.

The former is based on the law of heating in connection with continuous currents, while the latter is from Ohm's law; and therefore, in order to apply them for alternating currents, a *percentage* must be allowed for inductive effects.

By the use of the two diagrams combined, practically no calculations are necessary; the diagrams are simple and easily understood, while they cover the facts broadly. It will be observed that the sizes of the conductors are given in B. & S. gage, thereby dispensing with the use of wire tables, heretofore necessary.

The lines crossing the abscissas and ordinates represent ratios between the number of lamps multiplied by the distance in feet, and the percentage of energy wasted, or number of volts lost, while the ratios also represent the sizes of wire

One is not confined to the voltage specified, because the number of volts wasted may be found, and they represent percentages of any voltage. The same holds good with the lamp columns, because the 55-volt column may also be taken as ampères, and by determining the capacity of any other lamp in ampères we may take the 55-volt column for a comparison.

Example.—Find the size of a conductor in B. & S. gage necessary to carry sixty 55-volt lamps 100 ft. at 3% loss.

From the diagram we find that the size of the conductor would be represented by a line drawn to intersect the ordinate representing 60 × 100, or 6,000, and the abscissa representing the loss of energy, which is 3%. No line is drawn at exactly that point, but the nearest one will answer in practice, which is equal to No. 1 B. & S. gage.

After determining the size of a conductor by the above method it is then necessary to determine from the heat diagram if the conductor is of sufficient cross section to prevent excessive heat.

In that case the problem is to find how much a No. 1 B. & S. gage wire will heat, carrying 60 ampères. By using the diagram as previously explained, it will be observed that the wire will heat 18° Fahr., while for ordinary wiring 30° would not be considered too much. It would not be practicable to decrease the size of the conductor because it did not heat 30°, for the reason that a greater percentage of the energy would be wasted on account of the length, as a conductor offers resistance to a current directly proportional to its length, and inversely as its cross sectional area.

The ratios in this diagram are based on the use of 95% pure copper at 75° Fahr., as illustrated in Dr. MATTHIESSEN'S experiments. For any increase over 75° Fahr., therefore, 0.21° must be added (to the area of the conductor which would be the required size at 75° Fahr.) for each degree Fahrenheit increase.

On the Cleansing of the Streets and Removal of Household Refuse in German Towns.*

1. With whom does the responsibility for the cleanliness of the streets rest?

(a) *Streets, Squares, etc.*—Some German towns, such as Bremen, Cologne, Munich, make arrangements with contractors for the removal of all street refuse at a fixed rate (Contract System). In other towns (Berlin, Hamburg, Breslau, Frankfort-on-Maine, Hanover, Leipzic) the cleansing of the streets, and the watering of the same, etc., is carried out by the town authorities (Municipal System). The necessary plant, such as brooms, barrows, street-sweepers, dung carts, watering carts, snow plows, etc., are the property of those by whom the cleansing is carried out. The draught animals do not seem to be in any case the property of the municipal authorities.

Of 23 German towns, with a population of 100,000, in the year 1890:

13 employed municipal labor alone.
6 " municipal and private labor.
7 " private labor alone.

3. Time at which the cleansing is effected, and frequency of same.

The cleansing of the streets is, as a rule, only done at night, and the removal of refuse is also performed either at night or in the early morning. The frequency with which each street is cleansed depends upon the amount of traffic on the same. In Berlin one-third of the whole street area is cleansed daily. In Hamburg one fourth of the whole area. Household refuse is removed usually three times a week.

(a) *Thoroughfares and Foot-pavements.*—The principle generally acted on is, that the persons resident in a street and not the owner shall be responsible for its cleanliness. In spite of this, however, the cleansing of the streets is in most of the large towns undertaken by the municipal authorities. In other towns only a part of the roadway is cleansed at the expense of the authorities, the house-owners (resident) being responsible for the remainder.

Moreover, the authorities have also undertaken the cleansing of street-gullies, of public urinals, etc., the watering of the streets, and in most cases the removal of snow, etc. As a general rule tramway companies are obliged to contribute toward the cost of the cleansing of the streets. The cleansing of the footways and pavements is left to the resident householders. In Berlin and other large towns the pavements also are cleansed by the Municipal Authorities.

(b.) *Household Refuse (Dust).*—The removal of dust has in many cases (*e. g.* in Berlin) been left to the house-owners; the town authorities, however, retain a right of supervision. In cases were the contract system obtains (*vide infra*) the contractor undertakes the removal of dust as well.

2. Who carries out the cleansing of

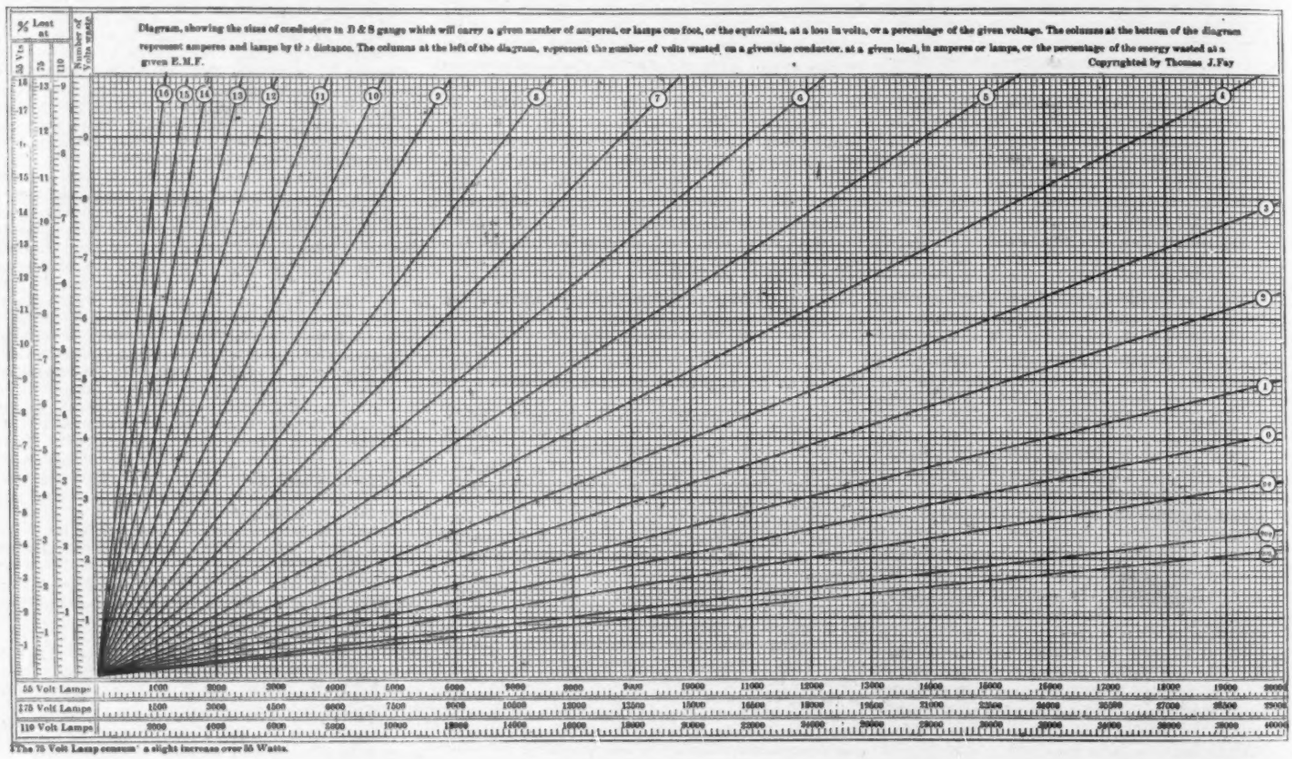
4. Comparison between the employment of manual and mechanical labor in the cleansing of the streets.

	Cost per hectare. Manual labor.	Mechanical labor.
Frankfort-on-Maine..	11 marks	6 8 marks.
Berlin.....	32 "	18 "

5. Disposal and utilization of street and household refuse.

Under the system of municipal working the utilization of refuse has up to the present been comparatively restricted. It is carted off to dust heaps and there left to so-called natural influences ("Natur-forschen"). From April, 1891, onward, the City of Berlin proposes to spread out its street refuse over some waste lands at a considerable distance from the city, so as to raise this low-lying and unproductive land to a higher level, and otherwise improve it. Under the contract system the contractors sell the household and street refuse as manure. The plan of separating the rubbish into useful and worthless parts does not obtain to any great extent in Germany. There is an establishment in Berlin for burning the refuse, but it is merely experimental.

*By Th. Weyl (Berlin). Read at the International Congress of Hygiene and Demography.


Diagram, showing the sizes of conductors in B & S gauge which will carry a given number of amperes, or lamps one foot, or the equivalent, at a loss in volts, or a percentage of the given voltage. The columns at the bottom of the diagram represent amperes and lamps by their distance. The columns at the left of the diagram, represent the number of volts wasted on a given size conductor, at a given load, in amperes or lamps, or the percentage of the energy wasted at a given E.M.F.
Copyrighted by Thomas J. Fay
% Lost at
Number of Volts wasted
55 Volts
75
110
55 Volt Lamps
75 Volt Lamps
110 Volt Lamps

WIRING DIAGRAM FOR USE IN CALCULATING THE LENGTH OF CONDUCTOR NECESSARY TO GIVE A CERTAIN DROP IN VOLTAGE.

The Social Statistics of American Cities.

The statistics contained in Census Bulletin No. 103 treat of the social organization of American cities, including their public improvements. This detail is of a nature that cannot be exactly stated in any reply to a census query; but the data here gathered together will answer sufficiently well for general comparison, and some statement of the growth and progress of these cities.

While 19 cities of a population entitling them to a place in such a general comparison have been omitted for lack of data, schedules were sent to 345 cities in the United States having a population of 10,000 and upward, and over 200 of these have made complete returns. In 1880 there were but 219 similar cities, with a combined population of 10,769,116. As the present population of the 345 cities noted is 17,291,479, the gain in population living in cities of this class is 60.57%, and the actual increase in the number of cities is equivalent to 57.53%. While the North Atlantic, or older States, still lead in the number of cities and population, the North Central group has increased 72.46% in the number of its cities, with an actual gain in population of 96.07%. The Western group has gained 130% in cities and 118.13% in population in cities.

This gain in cities of 10,000 and upward can be more plainly noted by condensing somewhat the table given in the Bulletin, as follows:

Divisions.	1890.		1880.		Increase over 1880.		
	No. of cities.	Total pop.	No. of cities.	Total pop.	No. of cities.	Population.	Per cent.
Total.	345	17,241,479	220	10,769,116	125	6,522,363	60.57
No. Atlantic. Maine to Penna.	143	8,468,779	104	5,990,416	39	2,478,36	41.37
So. Atlantic. Del. to Florida.	29	1,333,471	19	914,573	10	418,89	45.80
No. Central. Ohio to Kansas.	119	5,496,582	69	2,803,397	50	2,693,155	96.07
So. Central. Ky. to Arkansas.	31	1,092,307	17	647,97.	14	444,337	68.57
Western. Mont. to Cal....	23	900,370	10	412,760	13	487,610	118.13

Returns covering streets, street lamps, waterworks, sewers, police and fire departments, have been tabulated for 50 cities having a total population of 10,035,370.

Of these 50 cities 22 have a population of over 100,000 each, and a total of 8,737,648, or 12.95% of the population of the United States. The average density of population is 10,190 to the square mile, or 15.92 to the acre. But the range of density per acre is very great; passing, in round numbers, from 4 in Saint Paul, to 59 in New York. These figures, however, give no idea of the true density of population in the built up portions of the cities. Thus, in New York, the number of persons per acre ranges from 474 in Ward 10, to 3 in Ward 24; in Chicago the range is from 116 to 2 per acre; in Philadelphia, 163 to 1; in Brooklyn, 198 to 6; in Boston, 204 to 3; Baltimore, 141 to 3; Cincinnati, 162 to 3: Buffalo, 60 to 1; New Orleans, 56 to 2; Milwaukee, 43 to 7; Newark, 64 to 4; Minneapolis, 38 to 1, and in Saint Paul, 42 to 1 per acre.

Without reproducing the number of long tables given in this bulletin, we can state some of the various points deduced from these tables, and in doing so we, of course, use the returns as published. Taking street paving first, the bulletin says that the average yearly cost of repairs and construction per head of population in cities of over 100,000 inhabitants is $1.54; in 27 cities under 100,000 inhabitants, this cost is $2.04 per head. In 225 cities with a total population of 14,663,963, there are 35,723 miles of streets, of which 10,885 miles are paved, or 30.47%. The average annual cost of construction and repairs for the last 10 years was $25,256,551, or $1.72 per head of population per year. In another table given of 198 cities, ranging in population from 10,000 to 100,000, the average cost of street work per head per year is given as follows: $1.75 for 75 cities of 10,000 to 15,000; $1.07 for 55 cities of 15,000 to 25,000; $2.01 for 45 cities between 25,000 and 50,000, and $1.41 in 23 cities of from 50,000 to 100,000 inhabitants. The average of the 198 cities is $1.71.

In regard to public street lamps, 309 cities of 16,335,509 inhabitants have a total of 293,847 lamps. Of these 182,671 are gas lights, 53,696 are electric and 57,480 use oil. The annual cost of each street gas light varies from $50 in New Orleans; $43.80 in San Francisco; $37 in Saint Louis, to $15 in Indianapolis; $15.60 in Minneapolis, and $17.50 in Hoboken. The annual average cost of electric lights is—$440.67 in San Francisco, and $237.25 in Boston, down to $58.46 in Denver and $68 in Chicago. In cities of over 100,000 the average number of lamps per square mile is 219, or 13.5 to one mile of street. In cities of less than 100,000 the tables show an average of 62 per square mile, or 3.8 per mile of streets. The annual cost of lighting lamps, per head of population, ranges between 52 and 92 cts., with an average of 64. cts.

While the list given shows that 60% of all the street lamps are gas, another table shows that while 13 cities, with 231,049 inhabitants, use gas exclusively, 125 other cities, with 2,975,938 inhabitants also use electric light on the streets. Electric lighting is most favored among cities of less than 100,000 inhabitants.

The third detailed table is devoted to the waterworks of 50 of the largest cities in the United States, and of this number 35 cities own their own works. These 35 cities have an aggregate population of 8,704,603, and the works cost $185,849,414; the annual maintenance costs $3,791,041; the annual receipts from water rents are $13,232,162. The cost of the works per head of population is $21.33. In 13 cities, with 2,109,163 inhabitants, the works belong to private owners. They cost $37,720,877 as reported, and including capital stock. The annual cost of maintenance is given at $503,198; the annual receipts from water rents, $846,672, and the cost of the works per head of population is stated to be $31.20. The difference in cost of maintenance and receipts, between public and private works, is noteworthy. In cities of over 100,000 inhabitants, the average daily consumption per head is about 91 galls. But this varies from 196 galls. in Buffalo to 57 galls. in Indianapolis. In cities under 100,000 people the average daily consumption of water is figured at 83 galls., ranging from 165 galls. in Portland to 25 galls. in Fall River.

In a table covering 273 cities, with a population of 15,240,504, we find the total cost of works put down at $336,328,796; with 15,904 miles of mains, 1,504,890 taps and an average of 953 persons and 95 taps to each mile of main. Dividing this table into public and private ownership of works, we find that 56% of these 273 cities and 77% of the population own and operate their own works. In another table covering 245 cities, with 133 public and 112 private works, the relative cost and distribution stands as follows:

No. and ownership.	Population.	Total cost.	Miles of main.	Taps.	Pop. per mile of main.	Taps per mile of main.	Cost of works per head of population.
133 public..	3,708,994	$72,313,239	4,717	384,230	776	80	$19.50
112 private.	2,351,574	55,103,6a	3,480	173,757	676	50	23.43

The private works prevail in the smaller cities, 59 in the above list being towns with a population between 10,000 and 15,000.

The following table shows the distribution of sewers by population groups:

Population Groups.	Number of cities.	Total population.	Total length of Sewers.	Total cost.	Population to each mile of sewer.	Cost to Each Head of Population.	Cost for each mile laid.
				$			$
Total.....	149	3,941,770	2,574	33,517,276	1,531	$8.50	13,021.47
From—							
10,000 to 14,999	54	642,747	449	3,489,389	1,432	5.43	7 771.47
15,000 to 24,999	38	7 8,851	611	6,424,1 5	1 291	8.14	10.512 53
25,000 to 49,999	41	1,423,999	805	11. 83,290	1,644	9.07	13.260.1 5
50,000 to 99,999	16	1,086,562	648	12,121,442	1,677	11.16	18,705.9 3

In regard to sewers, the list of "50 largest cities shows that in 21 cities of over 100,000 inhabitants each, the total length of sewers is 32.77% of that of the streets, and the average number of house connections per mile of sewer is 113, serving 1,956 people. The average annual cost of maintenance and repairs per head of population is $0.065, as here figured out. In 27 cities of less than 100,000 each the percentage of sewers is 16.72 that of the streets; the average number of connections per mile of sewer is 47, serving 1,677 people. The average cost of maintenance and repairs per head of population is the same as for the larger cities. Washington and Cambridge have more miles of sewers than streets, while in Baltimore the sewers are only 3.56% of the street lengths, and are intended for the removal of storm water only. In 190 cities, with a combined population of 12,464,111, there are 6,883 miles of sewers, divided as follows: Pipe under 18 ins., 3,335 miles; pipe over 18 ins., 173 miles; brick or stone under 30 ins. 1,714 miles; over 30 ins., 1,506 miles. The average population per mile of sewer in these 190 cities is 1815.

In a table relating to the police of the "50 largest cities," we find in cities of over 100,000 an average of 13.55 patrolmen to each square mile, and 1.2 miles of street to each patrolman, who annually makes about 34 arrests. In these cities the cost of the police force per head of population averages $1.42, varying from $2.90 in New York to $0.46 in Omaha. In cities of less than 100,000 there is an average of 3.75 patrolmen to each square mile, and 4.3 miles of street to a patrolman, who averages about 51 arrests per year. The cost, as above, varies from $1.26 in New Haven to $0.60 in Nashville, and the average cost per head of population is 0.78. The average death rate among policemen in all these cities is 55 per 1,000. But this varies from 197 per 1,000 in Lowell, 133 per 1,000 in Hoboken, to 12 per 1,000 in New York and 15 per 1,000 in Minneapolis.

Concerning the fire departments, the average annual cost per head of population in 22 cities of over 100,000 inhabitants each is $0.81. This varies from $1.78 in Boston, and $1,06 in New York to $0 64 in Chicago, $0.60 in Philadelphia, $0.70 in Brooklyn, $0.62 in St. Louis, $0.35 in Baltimore and $0.92 in Cincinnati. In cities under 100,000 inhabitants the average annual cost is $0.71.

In 21 cities of over 100,000 inhabitants each the total loss by fire during 1889 was $2.20 to each head of population, ranging from $6.27 in Buffalo, $3.32 in St. Louis, and $3.11 in Brooklyn, to $1.11 in Baltimore, $1.02 in Newark, and $0.55 in Washington. In 27 cities of less than 100,000 inhabitants each the total loss by fire during 1889 was $1.45 to each head of population, ranging from $6.68 in Lacrosse, $4.97 in Portland, and $3.31 in Rockford, to $0.21 in Newport, $0.19 in Hartford, and $0.16 in Lawrence. The large fire in Lynn, Mass., $89.87 to each head of population, has not been included in any of the averages.

Municipal Engineering.*

When I submitted the titles of one or two subjects to the Committee of Selection of this Section and their choice fell upon that of "Municipal Engineering," I felt some difficulty in dealing with a subject of such magnitude in the short time which is allowed for the reading of papers. It will consequently be necessary for me to exclude all detail, and to condense what I have to say in as short a compass as generalities will allow.

In the spring of this year the *Times* and other newspapers contained some controversial correspondence upon the "Growth of Local Indebtedness," and when we consider that this growth has been mainly due to sanitary and other works carried out by municipal authorities throughout the country, it will be seen that the office of 'municipal engineer" to a local authority is of some importance where the disposal of such large sums mainly passes through his hands.

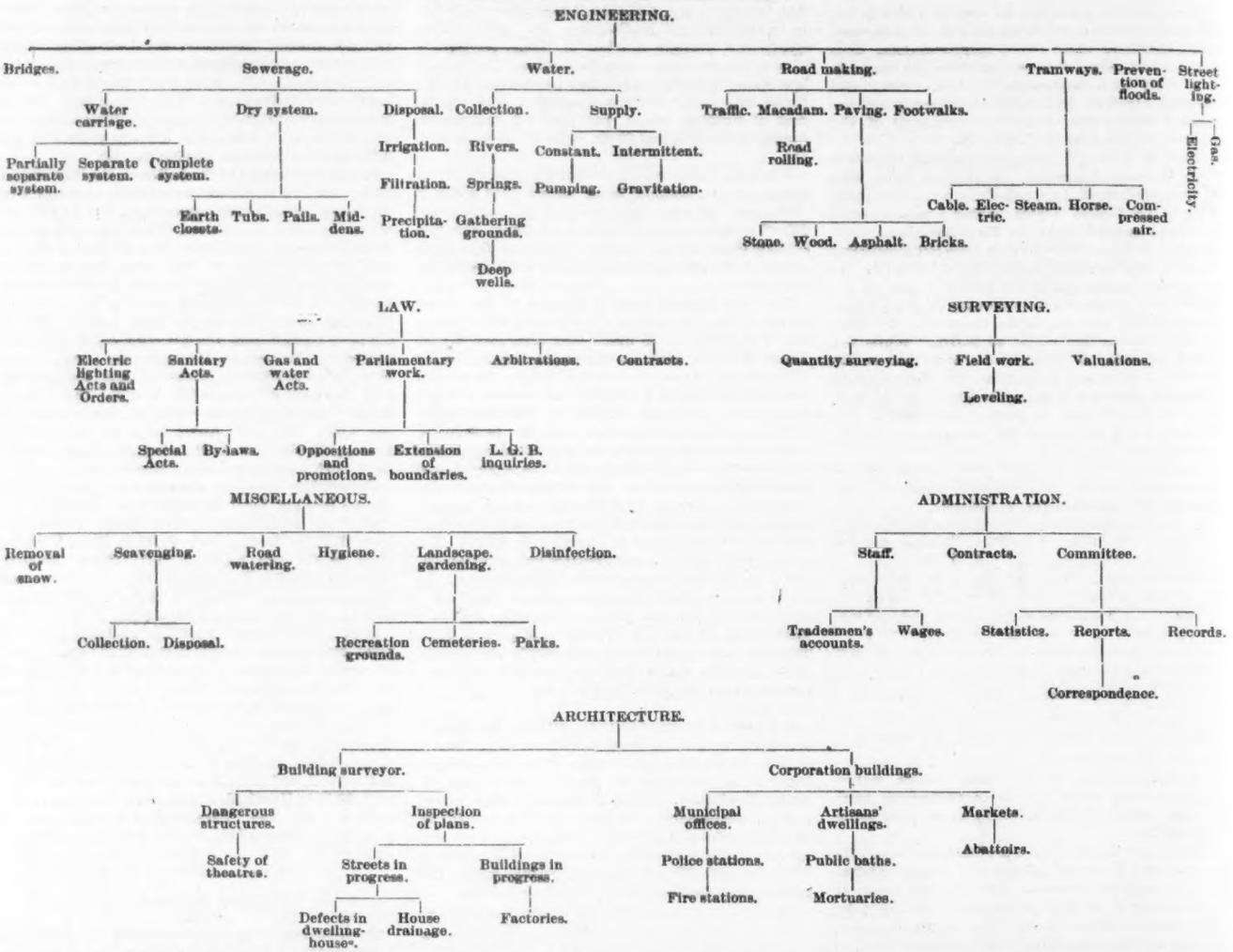
Sanitary engineering as a profession is of quite recent date. Fifty years ago very little attention was paid to sanitary matters, and the importance of pure water, fresh air, and the quick removal of organic waste were but little appreciated. Early in this century it does not appear that any towns possessed an officer whose duties were to deal with such subjects, and although a few of the larger cities became alive to the necessity of some action, and about the year 1810 some appointments were made similar to that of the "town surveyor," it was not till the year 1847 that this officer was first legalized under the Towns Improvement Clauses Act (10 and 11 Vict., c. 34, s 7†). This was confirmed in the following year by the Public Health Act, 1848 (11 and 12 Vict., c. 63, s. 37), and is now

* By H. Percy Boulnois, M. Inst. C.E., Fellow Sanitary Institute, Past President, Association of Municipal and County Engineers, Vice-President of the Section, and City Engineer of Liverpool. Read before the International Congress of Hygiene and Demography.

† The section is as follows:

"The Commissioners shall appoint, subject to the prescribed approval, or where no approval is acquired subject to approval by one of Her Majesty's principal secretaries of state, a person duly qualified to act as local surveyor of the paving, drainage and other works authorized under the provisions of this and the special act . . . and the Commissioners with the like approval may remove any such surveyor."

THE SIX CHIEF BRANCHES OF MUNICIPAL ENGINEERING.



law under the Public Health Act, 1875 (38 and 39 Vict., c. 55, s. 189).

In the early days of the "surveyor," as he is legally called, his work was, as a rule, very different from what it is now. In a paper by Sir Henry Acland, read before the Association of Municipal Engineers and Surveyors in 1876, upon "The Relation of Modern Engineering to Public Health and Local Government," we find the following:

"In the Public Health Act of 1875, the summary of all health enactments, the name of engineer does not once occur in the 343 clauses. He is still the old 'surveyor' we all remember, the plodding, energetic man of highways and byways, whose Anglo-Saxon vigor broke forth from the garb of corduroy, from the measuring tape and links into the transcendent skill of Macadam." . . . "But then the surveyor of the present day may be called to advise on anything, from the form and cost of an earthen syphon trap, to the calculation for work to be done by engines which are to supply half a million of persons with water . . . to be responsible for the construction of sanitary mechanism, from a housemaid's sink to an intermittent downward filtration farm. . . . He is to be able to carry out all measures for prevention of infectious diseases advised by the medical authority; he is faithfully to observe and execute all lawful orders of the Local Government Board which may be hereafter issued."

These words, by so eminent an authority as Sir Henry Acland, summarize the development of the town surveyor into the municipal engineer, and the duties of that office which he has touched upon open up the next part of my paper, that of the real work of the municipal engineer.

As I have already said it would be impossible in a paper of this description to detail all the work which this responsible officer has to execute, and I have, therefore, prepared the diagram, which will, I think, graphically describe some of the ramifications coming under the head of municipal engineering.

Having then described the ramifications of the diagram, and briefly alluded to the engineering and other topics set forth, I feel sure you will agree with me that municipal engineering requires a large and varied experience, unremitting labor and attention, and a constant acquisition of knowledge. Of the public advantages derived from this officer's work I will not dilate, well-paved and lighted streets, well sewered and drained towns, pure water delivered to all parts of our dwelling houses, the sanitary improvement of those dwelling houses, public recreation grounds and parks, the amelioration of the condition of the people, and many other things, all speak of the work of this officer. Time will not permit me to more than allude to his present position. I fear it will be many years before the ostentatious character of his work will be fully appreciated; local government is nearly always decried, the necessity for taxation in order to carry out unproductive works will for a long time be unpopular, but I believe that the day will come when nations will cease to glorify in politics, war, and pomp, and when those who are engaged in the daily task of battling against disease and death will take that position in the world which I believe is already accorded to them by those who are advanced in thought and science.

THE LETTER BALLOT ON NEW STANDARDS, just taken by the Master Car Builders' Association, has resulted in the adoption of a standard journal box bearing, wedge, and lid for 60,000-lb. cars, and a lid for the old standard journal box in place of the Fletcher lid. The proposed standard system for lettering freight cars, system of joint inspection, form of report of defective cars received and delivered, and joint inspection defect card, were all rejected; but each of them received nearly enough votes for adoption. The standard diameter of pins in air brake rigging was reduced $\frac{1}{16}$ in. A description in detail of each of these proposed standards will be found with our issue of June 13, 1891.

Novel Parcel Exchange System.

A rather novel and at the same time ingenious parcel exchange system has been devised by Mr. A. R. BENNETT, a member of the Institution of Electrical Engineers, and a gentleman who is well known in connection with telephony in the United Kingdom. In many of the large towns of this country the vehicular traffic is so heavy that in order to avoid absolute blocking of the thoroughfares, the collection or delivery of goods is forbidden in certain localities during business hours. The results of this restriction are that trade suffers and warehouses have to be made of larger capacity than would be necessary if the free receipt and dispatch of goods were permitted. With a view to overcome this difficulty and to allow of comparatively small packages being handled at all times, Mr. BENNETT has worked out a scheme (which is founded upon the "telephone exchange" principle) by which parcels could be readily interchanged between any number of buildings no matter how far apart they may be situated. It would occupy too much space, writes a London correspondent, to enter into the full details of the proposed system, but the following brief résumé may be found interesting:

The author proposes to effect this system of interchanging by the establishment of a number of miniature underground electric railways, radiating from a central station, and having branch lines or sidings into all the buildings to be served. According to this plan the railways would be laid in tubes of a rectangular section, and would be so arranged that the down track would occupy the lower portion and the up track the upper portion of the tube. The

tubes would be made sufficiently large—the author proposes 2 ft. wide by 3 ft. high—to allow of a man to creep through for examination and repairs, and in order to afford space for this the rails would be laid not on cross sleepers or ties, but on brackets fastened to the walls of the tube. Trucks actuated by electromotors would run on the rails, the current being obtained either from one of the latter or from a separate conductor laid parallel with the track. On the down journey the current would be collected by a kind of shoe pressing against the under side of this conductor, and on the up journey by a second shoe or collector. Separate collectors are, however, provided and connected with the motor, so that a truck could not travel in the wrong direction. The size of tube suggested by Mr. BENNETT would permit of trucks 20 ins. wide by 14 ins. deep being used, and their length might be considerable, but it would be regulated by the radius of the curves.

Each train would consist of a motor truck and one or perhaps two or three trailers or other trucks. The generating and operating station would be established in a suitable locality; in a large town there might be several. The station would contain the engines, boilers and dynamos, and might also be used as an electric light station. There would be arranged various turn-tables for the interchange of trains between the tubes, while sidings would be provided for empty trucks.

Coming now to the interesting point of delivery of goods, Mr. BENNETT says that connection with the premises of subscribers would be made by short spurs or sidings diverging from the nearest main tube. At the junction of the branches with the main tracks switches, similar to ordinary railway switches, would be placed and controlled by means of electromagnets by the operator at the central station. Various methods for finding and working any switch with certainty and rapidity are proposed, and also for ascertaining that the switch has been put over, or *vice versa*. The sidings into subscribers' buildings would consist of down and up tracks, but where space is available, they would be caused to diverge after entering the building and ultimately meet on one track, so that trains might be shifted from the down to the up track without lifting them off the rails. Various arrangements are provided for signaling and for informing the operator or operators of the progress or positions of the trains, and for the return of loaded or empty trucks from subscribers' sidings or on the main up line. The starting levers could be interlocked with the levers controlling the siding switches so that a following train could not leave until the switch for the preceding one had been restored to its normal position.

This scheme, which was fully set forth and illustrated by diagrams at the Cardiff meeting of the British Association, is rather startling, but Mr. BENNETT considers that the details do not comprise any device which has not been thoroughly tested in the telegraph and signaling departments of the post office and railway companies, or in connection with electric traction. He is of opinion that the system of electrical parcel exchange as proposed, would be invaluable to the various post offices, and to parcel receiving offices and great dispatchers of small packages; buyers could, he says, telephone for samples; hotels and restaurants could telephone for and receive in a few minutes supplies they may be short of, etc. As a parting shot, Mr. BENNETT gives a friend's suggestion that a mother could send her baby bodily to the doctor, *via* the central station, and receive it back with "a bottle of medicine in its fist and a mustard leaf on its chest."

Railway Progress in China.

It is evident that the strong opposition of the Chinese to the construction of railways in their empire, which evinced itself in 1877 by the destruction of the Shanghai-Woo-Sing line by an excited populace, is rapidly giving way to the necessities of the country, and that the lack of money, mainly, and not popular prejudice and opposition, hinders the work According to a recent letter from Tien-Tsin to the New York *Times* there are over 1,000 miles of railway projected for construction by the Chinese Government, and a foreign loan of $40,000,000 to provide for construction expenses is under consideration.

Neglecting the ill-fated road from Shanghai to Woo-Sing, which was largely experimental and adapted for passenger traffic only, the first railway opened for general traffic in China was the line from Tien-Tsin to Tong-Shang, 81 miles. This line was put in operation in September, 1888, and was fully described in ENGINEERING NEWS of Dec. 22, 1888. It is well constructed in every respect and cost, including equipments, 1,500,000 taels, or about $1,575,000. In December, 1890, an extension from Tong-Shang to Linsi was put in operation. This makes a total of about 100 miles of railway now in operation in the Chinese Empire. The next move will be to extend this line northeast to Shanghai-Kuan, near the eastern terminus of the Great Wall, a distance of about 80 miles. This is only the beginning, however, of a great northern line which will be about 800 miles long, and cost 12,000,000 taels, or $12,600,000. A small amount of surveying has been done on this extension, but as yet nothing has been made public.

Meanwhile considerable preparatory work has been done on another line which is projected to run from See-Kow Kiao, near Pekin, to either Wu-Chang or Han-Kow, and will be known as the Great Western Ry. The edict for this road was granted in August, 1889. Preparations for active work are now well under way at Wu-Chang. It will be the policy of the Chinese Government to use native material in the construction of these lines as far as possible. This has led to considerable activity toward the development of the iron mines in the vicinity of Huang-tze kang, about 100 miles down the Yang-tse-Kiang River, and large furnaces are being erected at Wu-Chang, together with the machinery necessary for the manufacturing of the pig iron. It is probable that a railway for transporting the ore from the mines to Wu-Chang will be built.

The government originally proposed that the money necessary for building this Great Western Railway, as well as the northern line, should be raised by the provincial governments at the rate of 2,000,000 taels per year, and the first year's collection was paid in. It was then decided to negotiate a foreign loan of $40,000,000 and the negotiations were well under way when the death of the Seventh Prince, who, with the Viceroy, Li Hung Chang, had the matter in charge, put a stop to the arrangements. It is probable that the money will soon be raised, however, and very likely by a foreign loan.

The only other line projected at present is intended to run from Canton to Kow-Loon, about 127 miles. The government's sanction only is necessary before beginning work.

It will be seen from the foregoing that the era of railways in China may be in sight. The opposition thus far, according to the *Times'* correspondent, has come from the government officers and the literati; the former because they will thus lose the ability to "fleece" the government in the transport of the tribute rice from the provinces to Pekin, and the latter because they fear that the spread of foreign ideas and innovations will destroy their prestige as scholars. This opposition will probably soon give way. The Grand Canal is stated to be no longer a great waterway, and the cart roads are at times impassable; while droughts and floods, as well as the possible exigencies of war, render additional facilities for the transportation of food imperative.

The History of Cartography.

An address on the above subject was delivered in the Geographical Section of the British Association at Cardiff by Mr. E. G. Ravenstein. He said:—We can hardly conceive of Joshua dividing the Promised Land among the twelve tribes and minutely describing their respective boundaries without the assistance of a map. A plan of Rome, the only document of the kind which has survived, is engraved on slabs of marble on a scale of 1.300, and was originally fixed against a wall of the Roman town hall, so that it might be conveniently consulted by the citizens. Of the existence of earlier maps of the world, or even of provinces, we possess only a fragmentary knowledge. That maps grew popular at an early age is proved by Aristophanes, who, in his comedy of "The Clouds," 423 B. C., has a map of the world brought upon the stage by a disciple of the Sophists, who points out upon it the position of Athens and of other places familiar to the audience. A real advance in cartography was made when Dicæarch of Messina (320-2 0 B.C.) introduced the parallel of Rhodes. This "diaphragm" was intersected at right angles by parallel lines representing meridians. Ptolemy of Alexandria introduced reforms into the methods of representing the earth's surface which fully entitled him to the foremost place among ancient cartographers. Before a map like his could be produced much preliminary work had been accomplished.

The gnomon, or sun-dial, an instrument known to the Chinese 600 years before Christ, had long been used for the determination of latitudes, and the results were relatively correct, although uniformly subject to an error of 16 minutes, which was due to the observers taking the altitude of the upper limb of the sun when measuring the shadow cast by their dial, instead of that of the sun's centre. It was known, likewise, that differences of longitude could be determined by the simultaneous observation of eclipses of the sun or moon, or of occultations of stars, and Hipparchus actually calculated ephemerides for six years in advance to facilitate computations. Ptolemy himself suggested the use of lunar distances. But so imperfect were the astrolabes and other instruments used by the ancient astronomers, and especially their timekeepers, that precise results are quite out of the question. Ptolemy, in fact, contented himself with accepting eight latitudes determined by actual observation, of which four were in Egypt, while of the three longitudes known to him he only utilized one in the construction of his map. No copy of Ptolemy's original set of maps has reached us. An examination of Ptolemy's maps shows very clearly that they were almost wholly compiled from itineraries, the greater number of which their author borrowed from his predecessor Marinus.

During the "Dark Ages" which followed the dismemberment of the Roman Empire there was no lack of maps, but they were utterly worthless from a scientific point of view. The achievements of the ancients were ignored, and the principal aim of the mapmakers of the period appears to have been to reconcile their handiwork with the orthodox interpretation of the Holy Scriptures. Hence those numerous "wheel maps," upon which Jerusalem is made to represent the hub, while the western half of the disk is assigned to Europe and Africa and the eastern to Asia. The Arabs were great as travelers, greater still as astronomers, but contemptible as cartographers. Their astronomers, fully possessed of the knowledge of Ptolemy, discovered the error of the gnomon, they improved the instruments which they had inherited from the ancients, and carefully fixed the latitudes of a great number of places.

Quite a new epoch in the history of cartography begins with the introduction of the magnetic needle into Europe. It is only natural that the Italians, who were the foremost seamen of that age, should have been the first to avail themselves of this new help to navigation. Germany, debarred from taking a share in the great maritime discoveries of the age, indirectly contributed to their success by improvements in mathematical geography and the introduction of superior instruments. The navigators of the early middle ages still made use of an astrolabe when they desired to determine a latitude. Great difficulties were experienced in the observations of longitudes. Lunar eclipses were most generally made use of. A congress of Spanish and Portuguese navigators met at Badajos and Yelves in 1524 for the purpose of laying down the boundary line, which Pope Alexander VI. had drawn at a distance of 370 Spanish leagues to the west of Cape Verd Islands, to separate the dominions of Spain from those of Portugal. Not being able to agree either as to the length of a degree, nor even as to that of a league, they separated without settling the question placed before them.

So uncertain were the results of observations for longitude made during the sixteenth and seventeenth centuries that it was thought advisable to trust to the results of dead reckoning rather than to those of celestial observations. But the method of dead reckoning is available only when we have a knowledge of the size of the earth, and this knowledge was still very imperfect, notwithstanding the renewed measurement of an arc of the meridian by Snellius, the Dutch mathematician (1615). This measurement, however, is remarkable on account of its having for the first time applied the exact method of triangulation to a survey. The problem of measuring the ship's way had been attempted by the Romans, who dragged paddle wheels behind their ships, the revolutions of which enabled them to estimate the distance which the ship had traveled. The eminent position which Italian cartographers occupied during the fourteenth and fifteenth centuries had to be surrendered by them in the beginning of the sixteenth to their pupils, the Portuguese and Spaniards, upon whom extensive voyages and discoveries had conferred exceptional advantages. These, in turn, had to yield to the Germans, and later on to the Dutch, who were specially qualified to become the reformers of cartography by their study of mathematics and of the ancient geographers, as also by the high degree of perfection which the arts of engraving on wood and copper had attained among them.

German mathematicians first ventured to introduce the long neglected geographical projections of Hipparchus and Ptolemy, and devised others of their own. The German cartographers of that age are to be commended, not because they copied Ptolemy's maps, for in this they had been preceded by others, but because they adopted his scientific methods in producing maps of their own. Their reforms began at home, as all reforms should. They

were amply supported in their efforts by the many astronomers of note of whom Germany then boasted, and by quite a staff of local "geographers," of whom nearly every district of the empire boasted the possession of one. Perhaps the earliest general map of Germany, and certainly one of the most interesting, was that which the famous Cardinal Nicolas of Cues, or Cusa, completed in 1461, the only existing copy of which is to be found in the British Museum, where it was "discovered" by Baron Nordenskjöld.

Mr. Ravenstein continued his historic sketch of progress, noting the introduction of the telescope, the theodolite, the sextant and the camera, the discoveries of the aberration of light and of the mutation of the earth's axis, the invention of instruments for measuring the depth of the ocean and the use of color in maps. The credit of having done most toward the promotion of cartography in the course of the eighteenth century belongs to France. It was France which first equipped expeditions to determine the size of the earth; France which produced the first topographical map based upon scientific survey, a work begun by César François Cassini in 1744, and completed by his son five years after his father's death; it was France, again, which gave birth to D'Anville, the first critical cartographer which the world had ever seen. D'Anville (1697-1782) swept away the fanciful lakes from off the face of Africa, thus forcibly bringing home to us the poverty of our knowledge, and boldly refused to believe in the existence of an Antarctic continent carrying half the southern hemisphere.

While France led the way England did not lag far behind. Since the beginning of the present century Germany has once more become the headquarters of scientific cartography, and this is due as much to the inspiring teachings of a Ritter and a Humboldt as to the general culture and scientific training, combined with technical skill, commanded by the men who more especially devoted themselves to this branch of geography, which elsewhere was too frequently allowed to fall into the hands of mere mechanics. And now, at the close of this the nineteenth century, we may fairly boast that the combined science and skill of surveyors and cartographers, aided as they are by the great advance of the graphic arts, are fully equal to the production of a map which shall be a faithful image of the earth's surface.—*The Architect*.

Compounding Centrifugal Pumps.

In our issue of April 4 we published a diagram of the efficiency of centrifugal pumps, showing that the efficiency is greatest (reaching nearly 70%) when the pump works under heads of 15 to 25 ft. For heads greater or less than this, the efficiency falls off very rapidly. In a letter to the *American Machinist* Mr. W. H. Booth proposes a simple plan for obtaining the same efficiency with centrifugal pumps when working against high heads as when working against the head at which they have greatest efficiency. He would compound the pumps, arranging one to deliver into the supply pipe of the other. The gain would be made not only in efficiency, but in the smaller wear and tear of the pumps working against a lower head. We publish the substance of his letter as follows:

Centrifugal pumps depend, of course, for their useful effect upon the tendency of water or any other ponderable substance to fly outwards from the center of a vortex. The maximum velocity of whirl possible is, of course, that of the tips of the fan blades. We may curve the vanes backward or forward with the idea of improving the action of a fan or pump, and to some extent we may do this; but any improvement effected is not due to any change of velocity, but to reduction of eddying and churning. Indeed, I have found by actual experiment that a fan so arranged as regards blade inclination, that the inner ends—as the inventor had it—skimmed a shaving off the cylinders of air entering at each side of the casing, gave a decidedly better result than an equal size of plain radial-bladed form, both fans working under exactly similar conditions, and in the same casing, that of the plain fan. Necessarily the pressure of the column issuing from a centrifugal pump is directly dependent on the tip velocity, and if we know the tip velocity we know the theoretical height of discharge of the pump, this height being that which would give the aforesaid tip velocity of discharge.

Thus a body falling from a height of 100 ft. acquires a velocity of 80 ft. per second, and a fan of 2 ft. diameter would require to run at 764 revolutions per minute to have such a tip velocity as this, though it would require to run considerably faster to pump against a head of 100 ft., on account of loss of efficiency, so much of the water escaping without acquiring the maximum velocity.

If a pump be set to work against a resistance greater than it can overcome, it will at once absorb less power than when moving a stream of water, because the fan and the water in the pump casing all revolve together, and the only resistance to rotation is the friction of the water upon the casing, and the only work done is really the overcoming of this friction. Reduce the head of resistance so that the pumps can overcome it, and at once water begins to flow through the pump, and, as each particle has to be put into motion, power is absorbed.

This action of a pump is a reason why centrifugals so often fail when made to draw up their water by "suction." Air gets into them, and being imponderable, or nearly so, cannot be energized by the fan, and all action ceases.

Hence water should, if possible, not be many feet below the pump. It is sometimes said that centrifugal pumps are not available above very moderate heights. This is true to the extent of our practice, because the high tip velocity demands either a very small inlet or involves too great an entering shock. Are there any sound reasons against the compound working of such pumps, by which I mean first getting up the water to say half the velocity corresponding to the total head in one pump and discharging it upon a second pump revolving at a higher velocity? Of course the entrance channels of the second pump would not be parallel to the axis of rotation, as is usual with centrifugal pumps, but would be arranged so that the column discharged from the first pump should enter the second pump in the direction of the fan rotation. To my knowledge, this compound system of centrifugal pumping has never been tried, but I can see no reason why it should not, equally with compound steam working, be an extensive means of extending the practical range of the centrifugal system. Of course the velocity of the inner ends of the vanes of the second fan should be equal to that of the tips of the first fan, and properly proportioned pipes should be employed between the two pipes, so as to avoid changes of velocity of flow.

Thus the stream will enter the second pump at the same speed as the vanes it encounters, and there will be no shock and comparatively little eddying; and the relative efficiency of the second pump, which does not have to change the flow of the water through an angle of 90°, will be greater than that of the first pump, which receives water in a direction 90° removed from the plane of discharge.

It will be noted that the writer supposes that it would be necessary to run his second pump at the same speed as if it were working alone against the total head. Of course, if the second pump were placed half way up the shaft, each pump would then work against half the total head, and at a corresponding velocity. Query: Would this also be true when both pumps are placed at the bottom of the shaft and one pumps into the other? What do the readers of Engineering News think about it?

Temperature in the Wheeling Well.

At the Washington Meeting of the American Scientific Congress Prof. William Hallock, of the U. S. Geological Survey, read a paper on the deep well near Wheeling, W. Va. This well is 4,500 ft. deep, is 4¼ ins. in diameter and is dry and cased only for 1,570 ft. It has been donated to science by the Wheeling Development Co. who started it for oil.

The strata passed through are nearly all *in situ*, undistorted and dipping only 50 ft. to the mile. The geological conditions are thus nearly perfect. In taking the temperature, as the well is dry, ordinary U. S. signal service maximum thermometers were used, and these were lowered by a steel wire. The results are given as follows:

TABLE I.

Depth. Feet.	Temp'ure Fahr. Deg.	Depth. Feet.	Temp'ure. Fahr. Deg.
1,350	68.75	3,125	88.40
1,591	70.15	3,232	89.75
1,592	70.25	3,375	92.10
1,745	71.70	3,482	93.60
1,835	72.80	3,625	96.10
2,125	76.25	3,730	97.55
2,236	77.40	3,875	100.05
2,375	79.20	3,980	101.75
2,436	80.50	4,125	104 10
2,625	82.20	4,200	105.55
2 740	83.65	4,375	108.40
2,875	85. 5	4,462	110.15
2,900	86.60	....	....
		100	51.30

These observations when plotted show a slow increase for the upper half of the uncased portion, about 1° Fah. for 50 to 90 ft., whereas the lower part shows a more rapid increase, about 1° Fah. for 60 ft. The whole series giving a well-defined and regular curve, with a deflection at 2,900 to 3,000 ft. where an oil sand occurs. Practically all the rest of the uncased well is in shale. The increase in the rate at which the temperature rises as the bottom is approached can only be temporary, or there would be an inconceivable or improbable state of temperature at comparatively slight depths. The two distinct series of observations combined in Table I. nowhere disagree more than 0° 3 Fah., and hence are very reliable and accurate.

Table II gives comparison of the results at the three great wells, two in Europe and the one at Wheeling.

TABLE II.

Name of well and location.	Feet for 1° Fh.	Total depth.	Temp. at top.	Temp. at bottom.
Sperenberg, near Berlin	59.2 ft.	4,170 ft.	47°.8	118°.6
Schladabach, near Leipzig	63.0 ft.	5,740 ft.	51°.9	135°.5
Wheeling Development Co		4,500 ft.	51°.3	110°.3
Top and greatest depths	74.3 ft.	4,500 ft.		
Mean of lower 3,000 ft.	75.4 ft.	4,500 ft.		
Mean of the above two	74.9 ft.	4,500 ft.		

Inasmuch as the bottom of the well is some 3,700 ft. below sea level, it seemed worth while to attempt barometer readings in it. The instruments used proved ill adapted to the work, and the results were unsatisfactory. A series of observations in a coal mine near the well gave a very probable value of the temperature of the top invariable stratum: 51°.3 Fah. From the mean annual temperature of Marietta and Steubenville it might be taken at 52°.2 Fah.

Drilling is temporarily stopped, but it is expected to go 5,500 to 6,000 ft. Mr. Anton Reymann, of the Development Company, has generously guaranteed half the expenses and the scientists are waiting for a lucky man to furnish the other $3,000 and enable Wheeling well to be lifted from the second to the first place among the deep wells of the world.

The Glasgow Harbor Tunnel.

The need for better communication between the opposite sides of Glasgow harbor has been discussed for some time. In 1889, parliamentary power was granted for a tunnel under the Clyde; and in August of the same year the Glasgow Harbor Tunnel Co. was incorporated with a share capital of $675,000 and borrowing power to the extent of $225,000 more. Messrs. Sampson and Wilson were appointed the engineers, says our contemporary *Industries*, from which we take this account.

The tunnel proper is a little over 700 ft. long, terminating at each end in a shaft 80 ft. in diameter. Thereare three tunnels side by side, with the bottoms about 62 ft. below high-water level. The two shafts are 72 and 75 ft. deep, and were sunk by excavating inside a double skinned lining of cast iron plates, and this shell was afterward filled with concrete. The tunnels are circular and are located only 2 ft. apart outside; they are 18 ft. in diameter inside for the brick-lined approaches, and 16 ft. for the cast iron parts, immediately under the river. The brick portions pass through boulder-clay and have a concrete invert with a 5 ring brick lining. The cast iron section is made of rings 18 ins. long, made of plates each about 4 ft. by 18 ins., with a smaller closing plate at the top. The inside flanges are 6 ins. deep (from outside of plate), with 1 in. thickness of plate and 1⅛ ins. thickness of flange. These segments are joined by ¾ in. bolts spaced about 9 ins. apart, leaving a space of ⅛ in. between the flanges for wedging with soft pine wedges. The iron used is tough Scotch grey iron, which is required to bear a tensile stress of 6½ tons per square inch, before fracture, and 2½ tons without loss of elasticity. The iron is dipped in boiling tar and pitch and all exposed parts receive two coats of Carson's patent anti-corrosive white paint.

The two tunnels for vehicles are almost level, and elevators will lift these to the surface through the shafts. The tunnel for foot passengers rises about 1 in 3 at each end and is provided with flat stairs, thus avoiding lifts.

At the present time the two shafts are completed; the west tunnel is driven 150 ft. and the east about 100 ft. Shields and air-compressing plant are being set up for use under the river, where the crown of the tunnel is only about 15 ft. below the river bed. Work was commenced in May, 1890, by the contractors, Messrs. Hugh Kennedy & Sons., and it is hoped that the undertaking will be completed early in 1892.

Indian Rock-Cut Temples.

Almost every one who sees these temples is struck with the apparently prodigious amount of labor bestowed on their excavation, and there is no doubt that their monolithic character is the principal source of the awe and wonder with which they have been regarded, and that, had the Kylas been an edifice of masonry situated on the plain, it would scarcely have attracted the attention of European ravelers at all. In reality, however, it is considerably easier and less expensive to excavate a temple than to build one. Take for instance the Kylas, the most wonderful of all this class. To excavate the area on which it stands would require the removal of about 160,000 cu. yds. of rock, but, as the base of the temple is solid and the superstructure massive, it occupies in round numbers about one-half of the excavated area, so that the question is simply this, whether it is easier to chip away 50,000 yds. of rock and shoot it to spoil (to borrow a railway term) down a hillside, or to quarry 5',(00 cu. yds. of stone, remove it probably a mile at least to the place where the temple is to be built and then raise and set it. The excavating process would probably cost about one tenth of the other. The sculpture and ornament would be the same in both instances, more specially in India where buildings are always set up in block and the carving executed *in situ*. Nevertheless, the impression produced on all spectators by these monolithic masses, their unalterable character and appearance of eternal durability, point to the process as one meriting more attention than it has hitherto received in modern times, and if any rock were found as uniform and as easily worked as the Indian amygdaloidal traps, we might hand down to posterity some more durable monument than many we are now erecting at far greater cost.—*Exchange.*

A Steep Mountain Toll Road.

We are indebted to Mr. J. W. SEDWICK, City Engineer of Pasadena, Cal., for the following description of the Pasadena and Mt. Wilson Toll Road, extending from the mouth of Eaton Cañon to the summit of Mt. Wilson in the Sierra Madre range of mountains in the county of Los Angeles, Cal.:

The length of the road is	9 miles 906 ft.
Elevation at starting point	1,200 ft.
" of Mt. Wilson	5,600 ft.
" to be overcome	4,400 ft.
Maximum grade of roadway	10%

The surveys for road were begun Nov. 12, 1890, and completed Jan. 15, 1891. The work of grading a 4-ft. trail on line of roadway was begun March 11, 1891, which work was completed July 31. The 4-ft. trail is now open to the public. The company are keeping a small force of men at work, widening out the trail into a wagon road.

Mt. Wilson is the proposed site of a 40-in. telescope and Harvard observatory. The glass for this telescope is now in the shops of ALVIN CLARK in course of preparation. Eaton Cañon, the starting point for the road to Mt. Wilson, is 5¼ miles from Pasadena. The mountains through which this road runs are very rough and precipitous. The cost of grading the 4-ft. trail was $5,000. The distance from foot of road at Eaton Cañon in a straight line to the summit of Mt. Wilson where trail ends is 3¼ miles.

STREET-REFUSE CARTS DUMPED BY STEAM are being tried by Commissioner BEATTIE, of New York. The body of the cart is made of sheet steel, and has a capacity of 60 cu. ft. The cart is two-wheeled and the body of the cart can be hoisted from the frame by a derrick-arm and swung out over the dump-scow, and is then emptied by opening one of its inclined sides, which is hinged at the top. The device saves time and an extra horse at the dumping-dock. About 74 of these carts are now in use by the Street-Cleaning Department.

APYRITE is the new Swedish smokeless powder. It is based, says *Engineering*, upon highly nitrated cellulose, with a low pressure of 2,200 to 2,500 atmospheres, and gives an initial velocity of more than 2,100 ft. per second. It gives out no flame, slightly heats the rifle, is like black powder in appearance black, bright and prismatic, and the products of combustion have an alkalic reaction. It is easy to manufacture and is made of two substances mainly; it is very little affected by rubs or blows, and burns even when ignited in large quantities without an explosion. With the present Swedish rifle 3½ grammes of apyrite is used with a bullet weighing 14½ grammes, resulting in a muzzle velocity of 640 m. or about 2,100 ft. per second and a pressure of about 2,200 atmospheres.

THE WORLD'S FAIR buildings, now being constructed, and according to contract price, would cost as follows:

Woman's building	$113,397.60
Fisheries building	157,822.40
Transportation building	210,171.60
Horticultural building	226,887.00
Mines and mining building	245,407.00
Electricity	295,081.60
Administration	370,627.00
Agricultural building	440,209.00
Manufactures and liberal arts building	1,100,000.00
Total	$3,089,592.60

These sums will be increased by extras for roofs, etc., in each case, and the contracts are not yet let for two of the finest buildings, Machinery Hall and the fine arts building. A large number of smaller buildings will also be needed.

A NATURAL GAS ICE-MAKING MACHINE has been invented by Mr. S. P. STIKES, of Buffalo, N. Y., and is thus described in a newspaper of that city: It is a high speed upright engine, operated directly by the pressure of from 150 to 200 lbs. in the natural gas as it issues from the gas main. The experimental engine developes from 5 to 6 HP. From the engine the gas exhausts into an iron box, 4 × 3 × 3 ft., and in expanding generates cold sufficient to form slabs of ice 3 ins. thick, to the amount of ¾ ton per day So says the account, and it is further stated that a plant agregating 1,500 HP., that can be sold, will also make 300 tons of ice per day. No estimates of the cost are given, but it is claimed to be cheaper and simpler than the ammonia process.

THE CITY & SOUTH LONDON RY. electric line is meeting with continued success in operation. At a meeting of the company in August it was stated that during the year ending June 30, the number of passengers carried was 2,312,000, an average of 17 per train mile, while on ordinary railways the average is 3½, or 5 including suburban railways. The earnings amounted to 66 cts. per train mile, and the expense of running about 22 cts. per train mile, as compared with 18½ to 25 cts. for ordinary steam railways. Two new boilers have been put in at the central power station, and a new engine and dynamo are being put in; 2 locomotives and 2 trains have been added to the equipment, and an improved system of electric lighting for the cars is being tried. The fare is 4 cts., and this is reduced to 2 cts. at certain times of the day. The bill for the northern extension of the line to Islington has been thrown out in Parliament, and the southern extension to Clapham will not be proceeded with directly.

THE RAPID TRANSIT COMMISSION of the city of Boston, Mass., has appointed Messrs. A. FTELEY, F. P. STEARNS, and THEODORE COOPER to act as an Advisory Board of Consulting Engineers, with their chief engineer. Mr. GEORGE S. RICE, in connection with the examination and study of the rapid transit problem of that city and its suburbs. The board met in Boston last week. All the gentlemen named are members of the American Society of Civil Engineers.

THE AREA OF FORESTS IN INDIA, in 1889-1890, according to *Indian Engineering*, was 56,821 sq. miles, demarcated and reserved by the state. The Central Provinces led the list with a total area of 19,707 sq. miles; Bombay came next with 10,349 sq. miles; and Assam had only 3,473 sq. miles.

THE ASBESTOS MINES of Canada produced 8,000 tons in 1890 as compared with the 50 tons taken from the same mines in 1878. It is found in the eastern townships near Quebec, and No. 1 Quebec now commands almost the same price as the best Italian asbestos, or from from $275 to $300 per ton for the best quality. The fibre is blasted out and separated from the rock by hammers.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Flint & Pere Marquette.—A large force of men is w at work upon the branch from Novi to Detroit, Mich.. 25 miles, and it is expected to have the line open for traffic by November.—The contract for building a lumber branch 8 miles long, from a point on the Harrison Branch, one mile north of Budd Lake, Clair Co., Mich., to the mills of Neff & Prestel and Wilson Bros., has been let to M. Lally, of Detroit, Mich. Work will begin at once.

Bristol.—This company, which is building a railway from Fairhaven Station to Bristol, Vt., 7 miles, has been reorganized and the following officers elected; President, P. W. Clement, Rutland, Vt.; clerk, C. M. Wilds, Middlebury, Vt., and treasurer, H. G. Smith, Rutland, Vt. Work is making good progress and it is intended to complete the road this fall.

Portland & Rumford Falls.—This company has secured the necessary right of way for its extension to Rumford Falls, Me., about 15 miles, and work, it is reported, will begin at once.

Grand Trunk.—Five miles of track have been laid on the branch from Waterloo, Ont., to Elmira, Ont., 11 miles, and grading is well advanced on the remaining 6 miles. The large bridge over the Conestoga River will soon be finished.

Elmira, Cortland & Northern.—The survey for the Camden, Watertown & Northern R. R., running from Camden to Watertown, N. Y., 65 miles, has been finished. The route is reported to be very favorable, affording light grades and curves. The only expensive work will be the bridges over Salmon River, near Pulaski, N. Y., between 500 ft. and 600 ft. long, and over the Black River, at Brownsville, N. Y., 200 ft. long. A 5-mile branch from Belleville to Henderson Harbor, has also been surveyed. Press dispatches state that the contract will be let at once and work begun within 6 weeks.

New York Central & Hudson River.—This company is reported to be considering the construction of a short railway from Redwood, N. Y., on the Rome, Watertown & Ogdensburg R. R., to Alexandria Bay, N. Y.

Lackawanna & Montrose.—This new railway from Montrose to Montrose Station, Pa., 10.68 miles has been completed and opened for traffic. The road will be operated by the Delaware, Lackawanna & Western R. R.

Toledo, Ann Arbor & North Michigan.—This company will build a branch from its main line near Clare, Mich., to the Doe and Tom Creek, to lumber mills owned by Davison & Gardner.

Pennsylvania.—It is stated that surveys will soon begin for a railway from Mann's Choice, Pa., to Brooks' Mills, Pa., 30 miles, connecting the Bedford and Morrison's Cove divisions of the Pennsylvania R. R. In connection with this line it is probable that the Dunning's Creek Branch will be extended from Cessna, Pa., to connect with the new road at Fishertown, Pa. The contract for the construction of the first named line is reported to have been let to a Col. Hobert, of Vermont.

Fall Brook.—This company is contemplating the construction of a line of railway from Wellsborough, Pa., via Wilson Creek to Blackwells, Pa., to open up new coal fields.

Worcester & Shrewsbury.—A stock company is being formed at Worcester, Mass., to extend this railway to Shrewsbury, Mass. H. H. Bigelow, of Worcester, Mass., is at the head of the enterprise. The proposed extension will be about 3½ miles long. There is a possibility of the line being further extended to Marlboro, about 14 miles.

Pennsylvania Midland.—It is stated that construction has been commenced on this railway from Stroudsburg to Scranton, Pa., 55 miles. John Jermyn, Scranton, Pa., President.

Terminal Co.—This company has been formed to absorb the belt line railway being built at Cleveland, O.

Ohio Southern.—This company is reported to be considering a 70-mile extension to Lima, O.

Projects and Surveys.

Interstate.—This company has been organized to build a railway from North Attleboro, Mass., to Providence, R. I., 12 miles.

Grayling, Twin Lakes & Northeastern.—The contract for building this railway from Grayling to Twin Lakes, Mich., 27½ miles, has been let to Wm. Crampton, of South Bay City, Mich. It is stated that a force of 500 hands will be put at work at once and that the line will be completed this year.

Utica & Unadilla Valley.—Delos E. Culver, of 145 Broadway, New York City, informs us that no contracts have yet been let for this road. The line as surveyed will run from Bridgewater to New Berlin, N. Y., 20 miles. About 8 miles have been partly graded and one mile of track laid. The average grade will be about 10 ft. per mile and the maximum curve is 5°. The route is through an agricultural country. About one-half of the right of way has been obtained, and $50,000 in local aid secured. A. C. Couch is President.

Susquehanna.—F. H. Goodyear, of Austin, Pa., President, writes as follows:

The surveys have been completed for this railway, which is to run from Costillo to Hulls, Pa., 14 miles. The route is through a mountainous country. There will be one bridge 70 ft. long. The principal business of the road will be in lumber and coal. Nearly all the right of way has been secured and the contracts for construction let to D. A. Craye, of Austin, Pa. C. E. Botsford, of Austin, Pa., is Chie Engineer.

SOUTHERN.—Existing Roads.

South Florida.—The contract for building the extension of this railway from Pemberton, Fla., north, has been let to Morgan, Reynolds & Walker, of Lakeland, Fla.

Bishopville.—This company will apply to the South Carolina State Legislature for a charter empowering extensions from Bishopville, S. C., northwest to the North Carolina State line, and from Atkins, S. C., southwest to a point on the Central R. R. of South Carolina.

Charleston, Cincinnati & Chicago.—A. N. Molesworth, of Johnson City, Tenn., Chief Engineer, is reported as saying that work would soon be resumed on the line from Johnson City, Tenn., to Minneapolis, Va., 90 miles.

Kentucky Midland.—The contract for building the extension of this railway from Paris, Ky., to Salt Lick, Ky., 46 miles, is reported let to E. P. Reynolds, Chicago, Ill.

Abingdon Coal & Iron.—The engineers of this company are surveying an extension from Damascus, Va., into the iron lands in Shady Valley. Construction is now in progress between Abingdon and Damascus, Va., 15 miles. J. C. Watson, Jr., Abingdon, Va., Chief Engineer.

Montgomery, Tuscaloosa & Memphis.—This company is endeavoring to secure a renewal of the $100,000 subscription from the city of Tuscaloosa, Ala., in aid of its proposed line. It promises to have the main line from Montgomery to Tuscaloosa, Ala., 107 miles, and a branch from Tuscaloosa to the Brook Wood mines, completed by Aug. 1, 1892, if the subscription is renewed.

Norfolk & Western.—It is stated that this company has raised the money necessary to complete the extension from Great Outburst, Va., to the North Carolina state line, 20 miles, and that the contracts for grading are let. There is also a rumor that it has purchased the partly graded line of the Cape Fear and Yadkin Valley R. R., from Mt. Airy, N. C., to the Virginia state line, 7.5 miles, and will complete it.—About 65 miles of track have been laid on the line from Elkhorn, W. Va., to Ironton, O.

Ohio River.—Tracklaying on the extension of the Ravenswood, Spencer & Glenville R. R., from Leroy to Spencer, W. Va., 16 miles has been commenced.

Bristol Belt Line.—S. L. Nicholson, of Bristol, Tenn., Superintendent, write us as follows:

About 5 miles of this road are now in operation, and an extension of 4½ miles is being built through Fairmount and Lakeside, Tenn., and North Bristol and Blountville, Va. The road is being built to develop property around the city of Bristol, Tenn., and its principal business will be the passenger traffic, although a general freight and passenger business will be done. The grades and curves are easy and the work light. All of the right of way has been secured free, and some other local aid obtained. The interest on the bonds of the company is guaranteed by the Bristol Land Co. About 50 men are now at work on the extension. S. L. Nicholson is in charge of work.

West Virginia & Pittsburg.—J. A. Fickinger, Weston, W. Va., Chief Engineer, writes us that about one-third of the extension from Flatwoods, W. Va., to the Gauley River, 35 miles, has been graded, and that tracklaying will probably begin about April 1, 1892. The Resident Engineers are: J. N. Alston, Albert Purdy and C. M. Riele.—On the 9-mile line from Newton to Florence, W. Va., about 3 miles of the grading is completed, and 100 men are now at work. Tracklaying will probably begin about April 1, 1892. W. C. Fawcett is the Resident Engineer, with offices at Shelbyville, W. Va.

Harriman Coal & Iron.—J. P. Suverkrop, Harriman, Tenn., Chief Engineer, writes us as follows:

This road is to run from DeArmond's Station, on the East Tennessee, Virginia & Georgia R. R., up the Little Emery River, Walls Hollow and Crooked Fork, to Big Brushy Mountain, a distance of 14 miles. About 7 miles have been graded and work is now in progress. The work is pretty heavy in some places, there being considerable rock work and several trestles. The maximum grade is 1½5 and the maximum curve is 100. All work will be first class. It is expected to have the line in operation in November or December. The object of the road is to open up the coal fields of Brushy Mountain, which are owned by the East Tennessee Land Co. Hood Tucker, of Oliver Springs, Tenn., is the engineer in charge of work, and Wm. Kenefick, of Oliver Springs, is the contractor.

Nashville & Knoxville.—A. J. Crawford, of Terre Haute, Ind., President, writes us that about one-fifth of the grading has been completed on the line from Cookeville to Standing Stone, Tenn., 17 miles. The work is very heavy, from one-half to five-eighths being rock work. It is expected to begin tracklaying about Oct. 10. King Bros. Construction Co. has the contract, and R. I. Moscrip is the engineer in charge of work, with offices at Cookeville, Tenn.

West Virginia Central & Pittsburg.—Jas. Parsons, of Davis, W. Va., Chief Engineer, writes us as follows:

Work is now in progress upon two extensions of this railway, running from Elkins, W. Va., to Beverly, W. Va., 7 miles, and from Elkins to Belington, W. Va., 17 miles. The grading has been completed on the first named line and 2½ miles of track laid. Tracklaying is now in progress. On the line from Elkins to Belington 12 miles have been graded and 3½ miles of track laid. Grading and tracklaying are now in progress upon the remainder of the line. About 400 men are now at work upon the two lines. The work includes three iron bridges over the Valley River, 248 ft., 320 ft. and 225 ft. long, respectively.

Projects and Surveys.

Welsh Colony.—Chartered in West Virginia to build a railway from the mouth of Holly River, on the West Virginia & Pittsburg R. R., to the town of Arvon, W. Va., 47 miles. Among the incorporators are: D. S. Thomas, Edwardsville, Pa., and W. J. Edmunds, of Nanticoke, Pa

Halifax & Indiana River.—Organized in Florida to build a railway from Daytona to Titusville, Fla., 50 miles. Robbins & Graham, of Titusville, Fla., are interested.

South Atlantic.—Chartered in Georgia to build a railway from Rome to Augusta, Ga., via Atlanta. The incorporators are: R. J. Armstrong, R. I. Fouchi and S. M. Knox.

Alcovey & Northern.—Chartered in Georgia to build a railway from Alcovey Station to Jersey, Walton Co., Ga. Among the incorporators are J. O. A. Bradford, W. H. Gunter and J. I. Harris.

Tobacco Belt & Florida.—A bill has been introduced into the Georgia Legislature to charter a company to build a railway from a point on the Savannah, Florida & Western R. R., between Climax and Faceville, Ga., to the Florida line, in Decatur Co. Among the incorporators are: T. W. Lester, G. P. Wood and C. H. Thomas.

Wayne Southern.—A bill has been introduced into the Georgia Legislature to charter this company to build a railway from Jessup, Wayne Co., Ga., south to Waynesville, Ga.

NORTHWEST.—Existing Roads.

Rapid City, Missouri River & St. Paul.—Myron Willsie, of Rapid City, S. Dak., Chief Engineer, writes as follows:

This railroad has been located from Rapid City to Pierre, So. Dak., 165 miles, and the contract for building 40 miles has been let to John Chamberlain, of Rapid City, S. Dak. The maximum grade is 80 ft. to the mile and the maximum curve is 6°. There will be a bridge over the Cheyenne River. The larger part of the right of way has been secured, and $135,000 in local aid obtained. Richard O. Lake, of Rapid City, S. Dak., is President.

Pacific Short Line.—The sale of this Nebraska railway, which was to have taken place Sept. 1, has been postponed.

Wadena & Park Rapids.—This railway, recently completed from Eagle Bend to Park Rapids, Minn., 55 miles, has been sold to the Great Northern Ry. Co.

Great Northern.—This company has filed notice with the Secretary of the State of Minnesota of its intention to construct a line from Wylie Station, on the St. Hilaire Branch, southwest to some point on the Fosston Branch, a distance of 100 miles.

Canadian Pacific.—Tracklaying has been completed on the extension of the Glenboro Branch from Methven to Nesbitt, Man., 6 miles.

Duluth, Red Wing & Southern.—An official of this company is quoted as saying that arrangements had been nearly completed for securing the capital necessary to complete this road. When completed the road will extend from Duluth, Minn., to Sioux City, Ia., a distance of 423 miles, and work will be pushed with vigor from now on. The next work will be the construction of 31 miles of track southwest from Zumbrota, completing the road to Owatonna. Twenty-five miles of track will also be added at once to the section being built south from Duluth, extending the line into the pine woods of northern Wisconsin. After these two small sections are completed the main attention will be paid to the construction of the bridge across the Mississippi at Red Wing, and finishing the line between that point and Duluth. Then, without any unnecessary delay, the road between Owatonna and Sioux City will be constructed. The portion of the line running through Wisconsin will tap a rich forest region, while the remaining portion lies across an equally rich agricultural country.

Minneapolis, St. Paul & Sault Ste. Marie.—Tracklaying on the line from Hankinson to Valley City, N. Dak., 90 miles, has reached the Cheyenne River, 40 miles north of Hankinson. The bridge at this point has caused some delay, but work will now be pushed rapidly ahead and the line completed to Valley City. It seems probable from the reports that the line will be extended from Valley City north within a short time, the contract for 150 miles being already reported to have been let. The design is to extend the road to the International line, where it will meet a branch of the Canadian Pacific Ry.

SOUTHWEST.—Existing Roads.

Gulf, Colorado & Santa Fe.—Rails sufficient to complete 10 miles of the extension east from Conroe, Tex., toward Cleveland, Tex., have been shipped from Chicago. A large force is now grading the roadbed. The line when completed will run from Conroe via Cleveland to Cold Spring, Tex., and will penetrate a fine pine timber region.

San Antonio & Aransas Pass.—All work has been stopped on this line between Lott and Cameron, Tex., by an injunction brought by the contractors, Gurley, Ross & Gurley.

Projects and Surveys.

Taylor, Bryan & East Texas.—This company will be organized to build a railway from Taylor, Tex., via Lexington, Caldwell, Bryan and Madisonville, to Trinity, Tex. Among the incorporators are: F. M. Mundane, of Lexington, Tex., and S. E. Barnes, of Trinity, Tex.

ROCKY MT. AND PACIFIC.—Existing Roads.

Southern Pacific.—It is stated that this company will begin active work in Oregon and Washington toward developing its lines in those states. Articles of incorporation have been filed at Salem by the Oregon & California R. R. Co. to build and operate a railroad from Portland along the Willamette River by way of Silverton, Coberg and Springfield, and the Middle Fork of the Willamette River, to the state boundary line between Oregon and California, and also from Portland south along the west side of the Willamette River to Airlie, Polk Co., and from rhence to the southern boundry of Oregon. Branches will be run as follows: From Silverton to Woodburn; from a suitable point on Howell's Prairie, between Silverton and Macteay, to the Waldo Hills, from a point opposite Scio, Toecio, Yamhill Co., west to Sheridan; from a point near Dayton, Yamhill Co., to Dayton, and such other branches as may be necessary. It is also proposed to purchase the property of the Oregonian Ry. and the Portland Valley.—The Southern Pacific has also purchased the partly completed Astoria & South Coast Ry., 15¾ miles long.

California & Nevada.—The extension from Orinda to Maple Grove, Cal., will be completed by Oct. 1. A further extension to Brodie, Cal., has been partly surveyed.

Burlington & Missouri River.—The extension of this railway into Wyoming has given rise to reports that the company would immediately continue the extension to Helena, Mont., and possibly to the Pacific coast. Thus far only 47 miles of track, from Merino to Gillette, Wyo., have been laid this season, and this was on a roadbed which was practically completed last year. It is doubtful if any further work is done until next season, if then.

Port Angeles & Southern.—It is stated that work has been commenced on this proposed railway from Port Angeles to Junction City, Wash., 40 miles.

Colorado.—A press dispatch from Colorado Springs, Colo., says:

Citizens of Hayden divide have started in to construct a road to Cripple Creek from that point, to connect with the Colorado Midland R. R. The road is to be 14 miles long and 7½ miles are already completed. The grade is easy and the cost will not exceed $500.

Coronado.—This company proposes to build an extension from San Diego, Cal., north.

Utah & Wyoming.—The *Salt Lake Tribune* contains the following notice of this enterprise:

The Utah & Wyoming R. R., a local enterprise organized about six weeks ago, evidently means business. Two corps of surveyors are in the field, the line has already been surveyed and the plats filed, and a force of graders is already at work. The incorporators are B. G. Raybould, S. F. Walker, W. S. Martin, Alfred Thompson, Henry Denhalter, W. L. Pickard, L. C. Karrick, Frank Knox, Theodore Brough and J. B. Taylor, of this city, and a number of Denver capitalists are interested in the eastern division, which will be known as the Wyoming & Eastern, and will connect with the Utah & Wyoming at Twin Creek. The local company has ample capital with which to carry on its operations. The completion of the road will give the Burlington & Missouri, of which the roads mentioned will be adjuncts, the most feasible route to the Pacific Coast. If all goes well the promoters of the Utah & Wyoming expect to have their line in operation before the expiration of six months.

Projects and Surveys.

Zuni Mountain.—Chartered in New Mexico to build a railway from near Chaves, Bernalillo Co., southwest to coal fields in the southern part of Valencia Co., about 75 miles. Among the incorporators are: N. B. Field and W. N. Weaver, of Albuquerque, N. Mex., where the principal offices will be located.

Tacoma & Seattle Air Line.—The preliminary survey for this railway between Seattle and Tacoma, Wash., has been completed. A favorable line is said to have been secured. G. W. Chapman, of Tacoma, Wash., is Chief Engineer.

Fresno & Santa Cruz.—A survey is being made for a railway from Santa Cruz, Cal., to Fresno, Cal. H. B. Hobson is at the head of the enterprise.

FOREIGN.

Mexico.—In regard to the present status of the new railway enterprise being undertaken on the concessions granted to Gen. H. Sturm by the Mexican Government, J. L. Butman, Chief Engineer, is reported as saying:

It is to be a standard gage road and about 350 miles long, running from the City of Mexico to a point on the Pacific coast, now known as Palizada Bay. The work of surveying the route has progressed rapidly. The entire route has been examined with a view of immediately running out the preliminary line from a point 124 kilos. from the City of Mexico. The preliminary has been run from the City of Mexico 124 kilos. to Jojutla and the road located for 27 kilos. from the City of Mexico to Contreras. The maps, plans, profiles and estimated cost of construction of these 27 kilos. are now in the hands of the company, and the contracts for construction of this part of the road are now ready to be let. The letting of the contracts will probably be done at once, and it is likely that a construction company, an independent corporation, will be organized by Denver men and the stock placed on the market. This company is to take the contract for building the entire line and will sub-let the actual construction to practical contractors. Several large Colorado railroad building firms are now figuring on the section of road now ready to be let.

The officers of the company are: George Tritch, President; H. Sturm, First Vice-President and General Manager; Phil Zang, Second Vice-President; J. J. Riethmann, Treasurer; J. L. Butman, Chief Engineer; Charles Wheeler, Secretary; A. B. Heath, Assistant Secretary. Its headquarters are in the Bank Block, Denver, Col.

Mexican & Northern Pacific.—Thos. Southerst, President of this company, has recently returned from an investigation of this enterprise, and according to press dispatches, is very favorably impressed and will recommend it to the English capitalists who are interested. The road will be about 1,300 miles long. It is stated that Elliott, Hass & Co., of Chicago, have contracted to build the road. Most of the material to be used and the rolling stock will be bought in the United States. The work of building the road, which is already begun, is to be done by Mexicans and Scandinavians.

Mexican Central.—This company will probably soon make arrangements for building its proposed branch from Tula, near the City of Mexico, to Pachue, about 45 miles.

CITY TRANSIT.

Horse Railways—*Harrisburg, Pa.*—The City Passenger Ry. Co. will extend its line in South Harrisburg.

Electric Railways.—*Westboro, Mass.*—An electric railway to Marlboro is projected.

Providence, R. I.—The Interstate Ry. Co. has applied for permission to build an extension of the electric lines to connect with Pawtucket, Acton and Attleboro. Mr. Dagget, of Attleboro, is President.

Schenectady, N. Y.—The electric railway company proposes to extend its lines and issue bonds for $300,000.

Saratoga, N. Y.—The electric railway has been purchased by an Albany syndicate, which proposes to extend the line and build branches.

Memphis, Tenn.—A company has been organized to build an electric railway to the suburban town of Raleigh, 9 miles distant. Contracts will be let shortly, and it is thought the grading and tracklaying can be completed by December, and the line opened in March. President, E. S. O'Connell; Secretary, E. Scott. Capital stock, $200,000.

Dandridge, Tenn.—The Dandridge, New Market & Indian Cave Rapid Transit Co. is having surveys made for its electric road. President, W. F. Park; General Manager, J. D. Robinson, of Knoxville; Engineer, C. C. Willis.

Riverside, O.—The Riverside Electric Street Ry. Co. has been organized to build a road to Sedamsville and Anderson's Ferry.

Cleveland, O.—The Woodland Ave. & West Side Street Ry. Co. has decided to increase its capital stock $900,000 for the purpose of converting the line to an electric system.

Whatcom, Wash.—The Thomson-Houston Co. will build an electric road 8¼ miles long. Contracts for grading, filling, bridging, etc., have been let.

Elevated Railway.—*Brooklyn, N. Y.*—It is reported that surveys are being made for the extension of the Kings County Elevated Ry., for a distance of 1 mile from the present terminus at Schenck Ave.

Dummy Railway.—*Helena, Mont.*—The Helena, Hot Springs & Smelter Ry. has been sold to Kennett McRae, at $36,000.

New Companies.—Tallapoosa Street Ry. Co., of Tallapoosa, Ga.; C. B. Hitchcock, R. L. Spencer, D. C. Scoville and J. W. Hyatt; $50,000. Detroit Citizens' Street Ry. Co., of Detroit, Mich.; $4,000,000. Chicago, Riverside & Western Street Ry. Co., of Chicago, Ill.; Lewis Lusk, C. E Sargent and G. N. Morgan; $500,000. Chicago Street Car Heating Co., of Chicago, Ill.; B. E. Van Auken, J. A. Long and S. L. Roberts; $100,000. Roanoke Electric Construction Co., of Roanoke, Va.; President, S. E. Haas, Chester, Pa.; Secretary, C. A. Pearson, Jr., Philadelphia, Pa. Citizens' Street Ry. Co., of East St. Louis, Ill.; J. A. Jones and G. Van Hornbeck.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Baltimore, Md.*—Plans for the new bridge across Jones' Falls, at this place, are being prepared by F. H. Smith. The City Commissioner can give information.

Morganton, N. C.—The County Commissioners of Morganton, N. C., will soon advertise for bids for the construction of an iron bridge across the Catawba River; bids to be made on a single span of 200 ft., and on two spans of 100 ft. each.

Watkins Hill, Ga.—H. T. Cooper will receive bids until Sept. 19 for the construction of a bridge across Dog River, at this place. Plans and specifications can be seen on application.

Leadvale, Tenn.—It is understood that the East Tennessee, Virginia & Georgia R. R. has decided to build an iron bridge over the French Broad River, near Leadvale, Tenn., to replace the long wooden bridge recently burned.

HIGHWAYS.

Massachusetts.—The contract for a new road at Ware has been awarded to R. D. Shanahan, of Cambridge. A new road about a mile long is proposed at Barre.

Maryland.—The people of Harford Co. are agitating against toll roads.

Michigan.—The contract for a stone and gravel roadway near Bay City has been let to J. G. Fehrenbach at $1.33 per rod.

South Dakota.—Work on the surveys for the road between Aberdeen and Pierre is progressing. The profiles of 16 miles from the Faulkton end, where the grade is completed, have been sent in and the surveying party have completed the work to Blunt. The grading contracts will be let for the balance of the road as soon as the profiles are all in. The money is now all in the hands of the treasurer for the completion of the grading.

WATER-WORKS.

NEW ENGLAND.

Farmington, Me.—It is proposed to take a supply from the Sandy River and pump it to a standpipe. The question will be voted upon Sept. 14.

Tyson, Vt.—The Reservoir Co. will take out the old dam at the outlet of Lake Amherst and build a new one.

Whitefield, N. H.—The town has voted to accept the proposition of a company to put in a system of waterworks at an annual rental of $2,000, with the option of purchase after 2 years. The supply will be taken from Slide Brook, 5 miles away.

Lancaster, N. H.—The new Lancaster Water Co. has asked the town to rent some fire hydrants. The company proposes to build works at a cost of $50,000.

Boscawen, N. H.—It is proposed to put in a system of water-works at a cost not to exceed $75,000. Water will be taken from Great Pond, and will be supplied to Penacook also.

Easthampton, Mass.—The town has made an appropriation of $15,000 for pipe lines and for a pumping station near the junction of Rum and Broad Brooks.

Manchester, Mass.—The town has voted an appropriation of $110,000 for water-works extensions.

Providence, R. I.—The Council has made an additional appropriation of $20,000 for the repairing of the Fruit Hill reservoir. The total cost will be about $95,000.

New Britain, Conn.—The city will raise $60,000 for constructing a new dam and appurtenances at Shuttle Meadow Lake. It is proposed to obtain power to issue bonds.

Taftville, Conn.—A contract for a new dam for the Ponemah Co. to form a reservoir for water supply has been awarded to Mr. F. B. Durfey.

MIDDLE.

Edwards, N. Y.—It is proposed to organize a water company. The supply would be pumped from the river through 2, 4 and 6-in. pipe to a tank on a hill at an elevation of 80 ft. above the streets and 120 ft. above the river.

Rochester, N. Y.—An extended report on the value and practicability of a storage reservoir on the Genesee River has been made by Mr. John Bogart, M. Am. Soc. C. E. A dam 100 ft. high is suggested.

Mount Vernon, N. Y.—The New York & Westchester Water Co. is laying 16-in. cast-iron mains from Pelham Manor to Pelhamville, and 12-in mains from Bartow to City Island and Pelham Manor. About 12 miles of pipe are now laid at Williamsbridge, South Mount Vernon, Westchester and Pelham, and it is expected to furnish a supply to Mount Vernon this fall. About 20 miles of pipe are to be laid. The Pocantico Water Co., which supplies Tarrytown, is also said to intend furnishing water to Mount Vernon.

Cazenovia, N. Y.—It is proposed to increase the capacity of the water-works.

Tonawanda, N. Y.—The Water Commissioners have decided upon the purchase of the water company's plant, paying $88,400.

Perth Amboy, N. J.—The Water Committee has reported in favor of a supply from Tennent's Brook, but Mill Brook is also considered. Investigations have been made by Mr James C. Rossi, C. E.

Bloomfield, N. J.—The Township Committee is considering the question of a new water supply. Negotiations are pending with the East Jersey Water Co. and the Montclair Water Co.

Reading, Pa.—Work on the laying of the 24-in. main to the Hampden reservoir was commenced about Aug. 20. H. E. Ahrens has the contract

Duncannon, Pa.—It is reported that water-works are to be established.

SOUTHERN.

Richmond, Va.—Superintendent Bolling has reported that the best method of purifying the water is to establish a large storage reservoir or settling basin above the pumping station. He recommends the use of meters, with low meter rates.

Wheeling, W. Va.—The Board of Water-Works Trustees has reported that a better and larger water supply is needed, with new and stronger machinery to pump water up to the reservoir. The cost of moving the works to a point above the city is estimated at $200,000 to $300,000.

Union City, Tenn.—Mr. P. P. Hurlbut, C. E., writes as follows;

I am here to erect the water-works at this place for Guild & White, engineers and contractors, of Chattanooga, Tenn. We are to put in 7 miles of mains, 2 pumps of 1,000,000 galls. capacity, in well 40 ft. below surface. Water supplied from three artesian wells 180 ft. deep. Will put in electric light plant, 100 incandescent street lamps of 50 c. p., and erect pump and power house. Material partly delivered. Work in progress.

Plaquemine, La.—The Plaquemine Water-Works Co. has been organized. President, J. A. Grace; Secretary, David Altemus. Capital stock, $15,000.

NORTH CENTRAL.

Zanesville, O.—The Water-Works Trustees have awarded a contract to the Holly Mfg. Co., of Lockport N. Y., for a new Gaskill crank and flywheel high duty pumping engine of 5,000,000 galls. capacity, for the new water-works extension.

Columbus, O.—The Ohio Water-Works Co., of Mansfield, has been organized for the purpose of supplying water from Lake Erie to all the cities from Sandusky to the Ohio River. Capital stock, $10,000. One clause of the incorporation papers authorized the company to acquire existing works by purchase or consolidation, but the Secretary of State refused to grant incorporation unless that clause was omitted.

Youngstown, O.—The water mains are being extended to Haselton. The Water-Works Trustees are contemplating improvements, including a main to Brier Hill and the enlargement of the Worthington pumping plant.

North Baltimore, O.—The North Baltimore Water-Works Co. has been incorporated. Capital stock, $100,000.

Toledo, O.—The Water-Works Trustees will carry out improvements and enlarge the pumping station to make room for the new engine. The cost will be about $30,000. The engine will be put in this winter, and will have a daily capacity of 15,000,000 galls.

Warren, O.—A contract for 8 years has been made with the Alliance Water-Works Co. for 13 plugs per mile at $40 per plug. The mains are to be extended.

Richmond, Ind.—Water-works are being built. Mr. O. Wendock, of Sandy Hill, N. Y., is in charge.

Northville, Mich.—The town voted on Aug. 31 to establish water-works, but it has not yet been decided whether it will be done by the village or whether a franchise will be granted to a company. G. A. Downes is village clerk.

Iron Mountain, Mich.—Mr. W. R. Coats, of Kalamazoo, is putting in a gallery for the city water supply and laying a submerged line of pipe 8,000 ft. long from the gallery through a lake.

NORTHWESTERN.

Plymouth, Wis.—The water-works question is being discussed.

Washington, Ia.—The city received ten bids for the complete water system and forty or fifty other bids for separate parts of the work. The contract was let to the Heidenreich Co., of Chicago, Ill., which has commenced operations.

West Union, Ia.—A water-works system is projected.

Tekaamh, Neb.—Mr. LaBelle, of Kalamazoo, Mich., has been appointed engineer to supervise the construction of the new water-works.

Rawlins, Wyo.—Proposals have been received by the City Council for putting in the new water-works. Dodge & Co., $30,000 bonds or $25,000 cash; J. E. Osborne and I. C. Miller, $27,700 bonds; Igo & Howard, $19,500.

Sheridan, Wyo.—Mr. Daniel Miller has been asked to make estimates on a water-works plant.

SOUTHWESTERN.

Kansas City, Mo.—An ordinance has been passed requiring the Board of Public Works to make a full report to the council as to the results of its investigations, and those of the board of experts, into the water supply question. The experts have located a site for a pumping station in Clay Co. The estimated cost is expected to be within the $2,000,000 appropriation.

Baird, Tex.—A water supply is to be obtained from wells 30 ft. deep and pumped to a tank of 50,000 galls. capacity. Wind and steam power will be used. The consumption is estimated at 24,000 galls. per day. The work will be done by a company with $20,000 capital stock.

Wichita Falls, Tex.—A water supply is to be obtained from wells.

Hondo City, Tex.—A water supply company has been organized.

PACIFIC.

Great Falls, Mont.—Mr. E. W. King, Superintendent of the Great Falls Water Co., writes as follows:

The city limits have been extended and the council has ordered 6½ miles more water mains laid; 900 ft. of 12 in. pipe of the above will be submerged pipe across the Missouri river. The water is 21 ft. deep at the deepest point. We will get bids on this, the pipe to be laid any time before the ice goes out in the spring. We also intend to erect a stand-pipe and filter plant in the spring, but the size of each has not been fully decided on yet.

Seattle, Wash.—Proposals have been received for 2 engines of 2,500,000 galls. capacity, or one of 5,000,000 galls., and the choice rests between the Holly and Worthington pumps.

Spokane, Wash.—The City Engineer has made an extended report to the Board of Public Works on different systems for the water supply of the city. The estimates are from about $300,000 to $600,000. Capt. Symons is consulting engineer.

Tacoma, Wash.—The special committee appointed last April by the Chamber of Commerce to investigate the water supply has reported that the available supply from Spanaway Lake, Clover Creek and springs in the southern part of the city is sufficient for 150,000 people. The committee reports that the water at its source is of a good quality, but that it is contaminated by being brought to the city through an old flume. A 40-in. steel conduit, at an estimated cost of $200,000, is recommended to replace the present flume.

Provo, Utah.—The contract for the water-works has been let to Rhodes Bros., of Denver, Colo. The main line of pipe from the Provo River will be of redwood, 4 ins. diameter for 4 miles and 12 ins. thence to the city. Capacity, 1,500,000 galls. per day; 78 hydrants. It is not yet certain whether gallery system or filtering process will be used. The works will cost about $120,000, and are to be completed by 1892.

Santa Rosa, Cal.—An improved and enlarged water supply is under discussion.

CANADA

Amherst, N. S.—A system of water-works is to be built at a cost of about $80,000. The supply will be taken from the Nappan River.

ARTESIAN WELLS.

Lowell, Mass.—The first well at the Boulevard has been completed under the direction of the Water Board.

South Haven, Mich.—It is proposed to organize a company, with a capital stock of $5,500, to put down a well.

Helena, Mont.—The Helena Artesian Well Co. opened bids Sept. 10 for a 6 in. well, 5⅝-in. casing, 2,000 ft. deep.

Fort Worth, Tex.—Several artesian wells will probably be put down by the city council.

Denison, Tex.—The Denison City Water Co. is sinking a third well at South Denison. The first two have a flow of about 20,000 galls. per day each.

Columbus, Tex.—H. A. Harris, of Houston, has put down a well with 4½-in. casing, 1,002 ft. deep, which yields 200,000 galls. per day.

IRRIGATION.

Nevada.—A movement has been inaugurated at Reno to organize an irrigation district on the Truckee, in conformity with the provisions of the act of March 23, 1891.

Washington.—Mr. Guy Stirling, of North Yakima, Chief Engineer of the Cowychee & Wide Hollow Irrigation District, writes as follows:

This district was organized a year ago under a law similar to the Wright law in California. It contains 40,000 acres of excellent sage brush level land. As soon as my estimates are completed the people of the district will vote bonds enough for construction. The water will be taken from the Tietan river some 30 miles west of North Yakima, and will be carried by canal and flume 13 miles down the Tietan cañon before coming into the lands of the district. Some months ago I was consulted as to the best method of irrigating the high level lands of the Moxee valley, belonging to the Yakima Land Co. I suggested and advised an artesian well system. They accordingly began to sink a well 2 months ago, and have struck at 450 ft. a flow of 1 cu. ft. per sec. In going down the well passed through earth, clay, cement gravel, soft sandstone, 40 ft. of basalt, granite.

Arizona.—It is stated that of the 6,488,320 acres of land in Yuma Co., at least 175,000 acres are reclaimable by the proposed Great Colorado Canal. The dam is to be located 28 miles above Yuma on the Colorado river, and the canal will run to the Gila river, across which the water will be carried in pipes or flumes. Capt. F. S. Ingalls, of Yuma, is President, and J. H. Carpenter, Superintendent.

California.—The Central Irrigation District ditch has been completed from the north line of Glenn Co. down to and through Colusa Co. to a point 13 miles due west of Colusa. In this stretch, however, there are yet about 11 miles to dig out; 6½ miles of the uncompleted stretch are on the Glenn ranch, the managers of which have fought irrigation and demanded pay for the right of way through their land. When the Central ditch is completed it will irrigate 156,550 acres of land. Work has been commenced to take the canal across Stony creek. This will not be completed until late this fall. The contract price for this work alone is $50,000. The canal will be taken under the creek through 7 wooden stave pipes, each 7 ft. in diameter. Stony creek at this point is 660 ft. in width. On either side there will be solid masonry abutments, each requiring 300,000 bricks.

SEWERAGE AND MUNICIPAL.

Sewers.—*Massachusetts.*—Amherst. Work on the sewer extension will be begun at once.—Salem. Sewer extension to Juniper Point and Salem Neck are proposed.—Woburn. The Sewerage Commissioners have appointed Mr. M. M. Tidd their engineer.—Northampton. The contract for a sewer on Eastern Ave. has been awarded to John Marsden, of Utica, N. Y.—Palmer. The estimated cost of the sewerage system is $26,000.

Rhode Island.—Newport. The council has decided to build a sewer to Coggeshall Ave. at a cost of $50,000.

New York.—Olean. A preliminary report on the proposed sewerage system has been made by Mr. J. A. Seymour, of Bradford, Pa.—Gloversville. It is proposed to convert Cayadutta Creek into a trunk sewer.—Brooklyn. The Department of City Works has approved the plans for a 60-in. sewer on North Fifteenth St. at an estimated cost of $108,000. The contract for the sewer at the foot of North Twelfth St. has been awarded to John Morrison at $14,000.—Sandy Hill. The village trustees have engaged P. H. Baermann to make a survey for sewerage.

New Jersey.—Summit. The Township Committee received 21 bids for its sewerage system, but all were thrown out owing to some informality, and the bidders were notified to send in new bids.

Kentucky.—Lexington. The Southern Construction Co. is building sewers and laying brick paving.

Mississippi.—Meridian. An election of the issue on $75,000 bonds for sewers will be taken Sept. 30.

Michigan.—Ypsilanti. A system of sewerage is under construction, according to plans and specifications furnished by Mr. W. R. Coats, of Kalamazoo, who is the consulting engineer. Mr. Geo. L. Pierson is constructing engineer.

Kansas.—Argentine. A system of sewerage is under construction, at an estimated cost of $40,000. The Kansas Paving & Construction Co. has the contract.

British Columbia.—Vancouver. The city has voted to put in a system of sewerage at a cost of $500,000. Bonds will be issued.

Street Work.—*Rhode Island.*—Providence. Granite block paving will be laid on Dorrance and Cranston streets.

Delaware.—Wilmington. The Street and Sewer Department will lay $30,000 worth of brick paving.

Virginia.—South Boston. A vote will be taken Sept. 16 on the issue of bonds of $15,000 for paving Main St.

Florida.—Orlando. It is proposed to issue $10,000 in bonds for street improvement.

Illinois.—La Salle. The city will spend about $30,000 on street paving.

Minnesota.—St. Paul. Proposals for paving Fourth St. ranged from $16,960 to $19,000 for cedar blocks on plank and $20,500 to $23,000 for cedar blocks on concrete foundation.

ELECTRICAL.

Electric Light.—*Manchester, N. H.*—Proposals for electric lighting will be received by the city on Sept. 25.

Memphis, Tenn.—The electric light company will put up lights on the poles of the electric railway for $10 per lamp per month.

Alton, Ill.—The Alton Gas & Electric Light Co. is making arrangements to put in an electric plant.

Pana, Ill.—The Modern Electric Light & Power Co. has purchased the plant and franchise of the Springside Electric Light Co., for $17,000. The former company will move the purchased plant into the city and put in arc lights instead of the incandescent now in use on the streets.

New Companies.—Henderson Electric Light & Power Co., of Henderson, N. C.; $10,000. Mascoutah Electric Light Co., of Belleville, Mo., George Posten, U. R. Hagist and F. Dilg. McCook Electric Light Co., of McCook, Neb., to furnish arc and incandescent plant; F. Camith, S. W. Duddleston. Geo. Bicknell, J. A. Wilcox; $30,000. Pacific Coast Fuel & Gas Co., of Chicago, Ill.; L. Annison, C. C. March, H. F. Miller; $500,000. Elgin Electric Heating Co., of Elgin Ill.; C. E. Jones, R. V. Botsford and F. R. Aller; $10,000.

CONTRACTING.

Street Work.—*Reidsville, Va.*—Proposals were opened Sept. 5, by the Street Committee for paving, etc. The bidders were as follows: *A*, Lea & Co., Danville, Va.; *B*, R. Taylor Gleaves, Lynchburg, Va.; *C*, Lane Bros., Winston, N. C.; *D*, W. H. Breen & Co., Alexandria, Va.; *E*, H. W. Bradley & Co., Richmond, Va.; *F*, A. M. Smith, Greensboro, N. C. The work includes 5,000 cu. yds. excavation, 5,700 sq. yds. granite block paving, 10,500 sq. yds. brick sidewalk, and 10,500 lin. ft. curbing.

		A	*B**	*C*†	*D*	*E*	*F*
Grading, earth, cu. yd.		$.17	$.20	$.22	$.19	....	$.25
" loose rock	"	.24	.40	.34	.30	$.50	.60
" solid rock,	"	.68	.80	.74	.50	....	1.00
Granite block pav.,	"	1.27	1.48 1.70	1.89 2.00	2.05	....	1.95
Brick sidewalks,	"	.88	.83 .61	.90	.85	.98	...
Curbing, lin. ft.		.49	.57	.64	.68	....	.68

* $1.48 for Lynchburg stone and $1.70 for Richmond granite; 83 cts. for Fayetteville brick and 61 cts. for Reidsville brick.

† $1.89 for granite, and $2 for vitrified brick.

Pipe Line.—*Toledo O.*—No bids have been received by the Natural Gas Trustees for the pipe laying recently advertised, and the work is now being done by the city.

Sewers.—*Brooklyn, N. Y.*—The following proposals for sewers in District No. 37 have been received by the Department of City Works. H. Bogert, $1.75, $2.35 and $3.50 per ft. for 12, 18 and 24 in. cement pipe; manholes, $40; street basins, $100. E. Gorman, 99 cts., $1.47 and $2.30 per ft. for 12, 18 and 24 in. pipe; manholes, $34; basins, $37.

Paterson, N. J.—The contract for a sewer to the Passaic River has been awarded by the Department of Streets and Sewers to John R. Lee & Co., of Paterson:

		Sewer on piles.	Sewer, upland. Vitrified invert.	Sewer, upland. Cement invert.
Brick sewer, per ft.			$13.14	$13.69
200 ft. of 108-in. diam.		$21.49	10.31	10 26
900 " 104-in.	"	17.76	9 29	9.24
2,400 " 81-in.	"	15.59	8.21	8.16
3,600 " 72-in.	"	14.16	6.74	6.79
4,400 " 60 in.	"	12.04	6.11	6.06
2,600 " 48-in. egg-shape		10.56	each	70.00
70 manholes			"	90.00
30 receiving basins			per cu. yd.	4.60
1,000 cu. yds. hard rock excav.			"	3.25
300 " soft "	"		per M. B. M.	25.00
50,000 ft. B. M. timber			per cu. yd.	6.70
Concrete			"	30.00
Masonry, 2d class				

Detroit, Mich.—Proposals received by the Board of Public Works for the construction of lateral sewers ranged from 60 cts. to $1 per ft.

Boston, Mass.—The Metropolitan Sewerage Commissioners have received proposals for three more sections of the Metropolitan Sewerage System. The diameter ranges from 5 to 9 ft. Section 20, Medford; length, 9,130 ft.; average depth, 16 ft.; 4,500 cu. yds. of brick masonry required. H. C. Eyre, $128,414; Richard Falvey, $113,555; National Construction Co, $102,652.50; Dennis O'Connell, $101,337; Thomas F. Maney, $97,335; D. H. Cram, $95 351.40; Collins & Fitzgerald, $93,202.5?; Moulton, O'Mahoney & Trumbull, $92,695; Metropolitan Construction Co., $91,897.60; R. Malone & Son, $91,600.50; Collins & Ham, $87,780.70 John Shehan, $85,018. Section 23, Everett: length, 2,300 ft.; average depth, 25 ft.; 1,800 cu. yds. of brick; E. S. Safford, $60,025; D. H. Cram, $48,418.20; Metropolitan Construction Co., $43,404; National Construction Co., $43,205; R. A. Malone & Son, $39,344. Section 40, Everett & Malden; length, 6,250 ft.; average depth, 16 ft.; 2,950 cu. yds. of brick and masonry: Aaron A. Hall, $86,104; Dennis O'Connell, $70,878.75; Collins & Ham, $75,287.50; Thomas F. Maney, $73,408.25; Metropolitan Construction Co., $53,797,50; Moulton, O'Mahoney & Trumbull, $63,450.50; P. A. Malone & Son, $61,818.75.

PROPOSALS OPEN.

Railway.—Construction of the Portland & Rumford Falls Ry. from Canton to Rumford Falls. Hugh J. Chisholm, President, Portland, Me. Sept. 21.

Dam.—Earth and masonry dam at Shuttle meadow. P. M. Blake, Engineer. Board of Water Commissioners, New Britain, Conn. Sept. 16.

Street Work.—Curbing and paving. H. H. Culbertsen, Controller, Oil City, Pa. Sept. 14.

Water-Works.—About 13,500 ft. of 12-in vitrified pipe, 12,000 ft. of 12 in., 7 tons special castings, 30 valves, 30 4-in. to 12-in. valves and valve boxes, 50 double-nozzle hydrants; pipe laying and reservoir. W. F. Markham, Chairman Water-Works Committee, Plymouth, Mich. Sept. 15.

Dredging.—In Penobscot River. Lt. Col. J. A. Smith, U. S. Engineer Office, Portland, Me. Sept. 25.

Bridges.—Shore protection of piles, brush and sand bags at Platte River bridge. T. Killeen, County Clerk of Dodge Co., Fremont, Neb. Sept. 22.

One wooden bridge and one stone box culvert. F. J. O'Flaherty, County Surveyor. Sept. 21

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rogers Locomotive Works, of Paterson, N. J., have an order from the Illinois Central for 20 consolidation engines, Belpaire boilers, cylinders 21 × 24 ins., driving wheels 56½ ins. in diameter, weight 68 tons; they are also building 10 engines for the Norfolk & Western. The Baldwin Locomotive Works, of Philadelphia, Pa., have delivered 10 engines to the Norfolk & Western. The Brooks Locomotive Works, of Dunkirk, N. Y., are building 9 six-wheel switch engines for the Illinois Central.

Cars.—The Terre Haute Car Works, of Terre Haute, Ind., are building 200 box cars for the Minneapolis & St. Louis. The Barney & Smith Mfg. Co., of Dayton, O., is building 18 vestibuled passenger cars for the East Tennessee, Virginia & Georgia. The Pullman Palace Car Co. is building 100 fruit cars for the Illinois Central. The American Car Co., of St. Louis, Mo., has been organized by Wm. Sutton, Emil Alexander and Ferd. Meyer; $100,000.

Headlights.—The National Electric Headlight Co., of Indianapolis, Ind., is said to have several orders on hand.

Rails.—The Maryland Steel Co. is rolling its first rails at the new works at Sparrow Point, Md.

Pipe Works.—The National Tube Works Co., of Boston, Mass., has consolidated with it the Republic Iron Works, of Pittsburg, Pa., the Monongahela Furnace Co., of Pennsylvania, and the Boston Iron & Steel Co., of Boston, Mass. Its business will include the manufacture of pipe, plates, bars, etc. President, E. W. Converse; General Manager, E. C. Converse. Capital stock, $11,500,000.

Companies.—Burkeville Granite Co., of Burkeville, Va.; President, W. L. Reid, Roanoke, Va.; Secretary, J. R. Collingwood, Roanoke, Va.; $50,000.

Metal Market Prices.—*Rails.*—New York: $30.75; old rails, $21.50 for iron and $17 for steel. Pittsburg: $30; old rails, $23.50 to $24 for iron and $17 to $17.50 for steel. Chicago: $31.50 to $33; light and street rails, $32.50 to $35; old rails, $23 for iron and $15 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.75 cts.; spikes, 2.05 to 2.15 cts.; track bolts, 2.7 to 2.8 cts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron or steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.75 cts. with square and hexagon nuts. Chicago: splice bars, 1.85 cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $18. Pittsburg: $14.50 to $16.50. Chicago: $14 to $16.50

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 52½ and 42½ per cent. on black and galvanized butt-welded; 6½ and 50 per cent. on black and galvanized lap-welded. Casing 55 per cent.

Lead.—New York: 4.52½ to 4.55 cts. Chicago: 4.3 cts. St. Louis: 4.2 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 1.95 to 2.15 cts. for tank, 2.25 to 2.6 cts. for shell, 2.4 to 2.6 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2.05 cts.; sheared steel bridge plates, 2.15 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.1 cts. for tank, 2.35 cts. for shell, 2.55 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.15 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.15 to 2.2 cts.; sheared steel plates, 2.2 to 2.25 cts. for steel; steel plates, 2.4 to 2.6 cts. for tank, 2.85 to 3 cts. for shell, 3 to 3.25 cts. for flange; 4.5 to 5.5 cts. for firebox; boiler rivets, 4.25 cts.